# British
# Phycological Bulletin

VOL. 2 No. 2

1961

*Issued by*
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# SOME REMARKS CONCERNING THE CLASS CHRYSOPHYCEAE*

by

Mary Parke

The Laboratory, Plymouth

At the International Botanical Congress in Montreal in 1959, I said, when referring to scale-bearing chrysophycean genera, " Excluding the coccolithophorids, the forms examined so far appear to fall into the same two series if grouped either on flagellum structure or on scale structure." In the present address I propose to enlarge on what I said concerning taxonomy in the Chrysophyceae, especially as many new facts have recently been brought to light. In the Chrysophyceae two series may be distinguished: the first includes genera with a pleuronematic flagellum (i.e. with flimmer) and scales (when present) impregnated with silica; the second includes genera with acronematic flagella only (smooth surface, without flimmer) and scales (when present) without any mineral impregnation. Recent work has already shown that some at least of the coccolithophorids must be included in the second series. The naked chrysophycean forms also fall into one or the other series when grouped on flagellum structure. The very recent work by Dales (1960) on the pigments of members of the Chrysophyceae also suggests that there are two series within the class, the same two series as those separated by flagellum or scale structure.

The first series includes such well-known forms as the naked genus *Ochromonas* and the scale-bearing genera *Synura*, *Paraphysomonas* and *Mallomonas*, all of which have one of their two flagella structurally similar to the diatom sperm flagellum, i.e. pleuronematic (Stosch, 1958b). The second flagellum is acronematic and therefore structurally different. Bourrelly's (1957) theory that in the Ochromonadales there is a gradual reduction in the size of the acronematic flagellum, until in *Mallomonas* it persists only as the photoreceptor peduncle while in *Chromulina* it has completely disappeared, is supported by the finding of a very short internal second flagellum in *Chromulina psammobia* in addition to the external pleuronematic flagellum (Fauré-Fremiet and Rouiller, 1957; Rouiller and Fauré-Fremiet, 1958). Some genera, e.g. *Pavlova*, also possess an accessory filiform organ for the temporary anchorage of the cell, comparable to the haptonema of the second series (see p. 48) but almost certainly different in structure since it contracts instead of coiling.

In addition to possessing a pleuronematic flagellum and a unique type of attaching organ, the structure of which is not yet known, the genera in this first series have their scales, when present, impregnated with silica. These scales, even in the small number of forms so far examined under the electron microscope, show as wide a range of structure, from the simple to the complex, as that found in diatom frustules. The outer face of the scale may have a smooth poroid or non-poroid surface, or it may bear any degree of ornamentation up to a most elaborate system of papillae, punctae, folds and ribs (Harris and Bradley, 1957, 1960; Houwick, 1952; Manton, 1955; Manton and Leedale, 1961b; Petersen and Hansen, 1956, 1958). The most complex types of scales appear to be the sculptured forms on a basic poroid plate, some of which show a structure which might possibly be comparable to the locular diatom wall. For example, the scales of *Mallomonas lychenensis*, replicated by Harris and Bradley (1957), show what might be classed as areolae fully open to the outside with a sieve membrane on the side adjacent to the protoplast, while in *Synura uvella*, illustrated by Petersen and Hansen (1956), parts of the scale on the basic punctate layer show strong ribs forming hexagonal meshes, each section being covered by a thin membrane with a single hole in it; these scales might be classed as having simple partially closed areolae. The inner face of the scales of this first series is recorded as being smooth, punctate or poroid; in no instance has it been recorded as showing a patterning of radial ribs or ridges, which is the characteristic patterning for the inner face of the scales of the second series.

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*The fourth presidential address, presented to the British Phycological Society on January 6th, 1961.

The second series also includes both naked genera, e.g. *Isochrysis*, *Dicrateria*, *Diacronema*, and scale-bearing genera, e.g. *Prymnesium*, *Phaeocystis* and *Chrysochromulina*, all of which possess two flagella, both acronematic in structure (smooth, no flimmer), which can be equal, subequal or unequal in length and can show homodynamic or heterodynamic motion or both (Parke, 1949; Parke, Manton and Clarke, 1955, 1956, 1958, 1959; Prauser, 1958). A third filiform organ, the haptonema, can also be developed, e.g. in genera *Prymnesium*, *Phaeocystis* and *Chrysochromulina*, and when present is used for the temporary anchorage of the flagellate or flagellate stage to a solid surface (Parke *et al.*, 1955). It can also persist as an anchoring organ during the early stages of the non-motile phase of the organism (Fig. 5). Whether or not the haptonema is present in all members of this series—in some forms in such a rudimentary state that it is not recognisable under the light miscroscope—is not yet known. I suspect that it may be present, in addition to the two acronematic flagella, both in the naked *Isochrysis galbana* and in a scale-bearing form (No. 133 in the Plymouth collection) which is similar to the genus *Dicrateria* except that it has a covering of scales. There is no genus described into which this scale-bearing organism can be placed if it lacks a haptonema.

In the second series the scales, when present, are extremely delicate and, as far as is known at present, are composed only of organic material. There is a basic type of scale found commonly throughout this series, often in association with others of markedly different appearance (Parke *et al.*, 1958, Plate III). This basic plate-type scale is usually round or oval, sometimes angular, the inner face showing a radiating pattern of ridges which reach to the edge of the scale, while the outer face usually shows a lattice of criss-cross striations or sometimes roughly concentric surface ridges, usually within a raised rim of varying width.

In the genus *Prymnesium* the short haptonema does not coil or contract, although it can bend, and the scales are of the basic type. In the genus *Phaeocystis*—probably better known in its non-motile phase—the motile phases of the type species are similar to *Prymnesium* in having a short non-coiling haptonema and the basic type of scale, but one phase has the scale covering enclosed in a network of fibres and probably represents the motile stage described by Kornmann (1955) as the "macrozoospore." The life-history of this organism is not fully understood.

Until the whole form-range has been studied, the genus *Chrysochromulina* may be taken to include all the organisms which show no detectable mineral impregnation in, or deposition on, their scales, and which have two acronematic flagella, equal, subequal or unequal in length, and a haptonema which is coiled when not extended as a straight rod. In this genus the length of the haptonema can be 2-20 times the body length (Parke *et al.*, 1955, 1956, 1958, 1959). Professor Manton's investigation of the internal structure of the haptonema has shown that, in contrast to the flagellum, it possesses three concentric membranes surrounding a ring of fibres and a central space. The number of component fibres in the ring seems to have the constancy of a specific character, e.g. six in *Chrysochromulina strobilus* (Parke *et al.*, 1959).

Many of the organisms placed in this genus possess dimorphic scales, but only in *C. strobilus* have two distinct types been demonstrated, arranged one beneath the other in separate layers. In this species cup-shaped scales with conical thickened bases are arranged in a very regular layer, and beneath them are plate scales, also in a single layer. Despite the two layers of scales, the species exhibits phagotrophy, which suggests that scale production must in some way be a cyclic phenomenon, a conclusion also reached in connexion with the scale arrangement in *C. chiton*. From the *Chrysochromulina* species so far studied, various modifications of the basic plate-type scale have been recorded, particularly the production of central spines, which usually (though not invariably) are attached by four decurrent ridges. Even with the covering of scales, all the described forms have been shown to exhibit phagotrophy.

During recent years some evidence has been accumulating which suggests a close relationship between some members of the Coccolithophoridaceae and the organisms placed in the second series. In Paris in 1954 I demonstrated for the first time by means of Professor Manton's electron micrographs that a number of chrysophycean forms possessed two acronematic flagella. Included among these forms was a coccolithophorid, *Syracosphaera carterae*, as well as both *Prymnesium parvum* and *Isochrysis galbana*; thus my 1949 statement was confirmed, that I could not find mastigonemes on either flagellum in *Isochrysis* by Loeffler's staining technique (Parke, 1949).

Stosch (1955, 1958a) then published the very exciting information that a coccolithophorid—again of the *Syracosphaera* type—had a non-motile " Heterococcus-phase " and a swarm cell of the *Prymnesium* type. Professor Chadefaud also brought to my notice Schlauder's (1945) publication in which she recorded three flagella in *Pontosphaera triangularis*, of which the third flagellum appeared to be more rigid than the other two; it may therefore be a haptonema.

More recently, Miss Adams and I have shown (Parke and Adams, 1960) that the motile Crystallolithus phase of another coccolithophorid, *Coccolithus pelagicus*, can be placed in the second series. It possesses two acronematic flagella, a haptonema of the *Chrysochromulina* type (i.e. it coils), and scales with a radiating pattern of ridges on the inner face, although the outer face appears to lack a raised rim; it can also be phagotrophic. It differs from the genus *Chrysochromulina* only when the scales have developed the deposit of calcite crystals which are laid down in a particular pattern on the scale to produce the holococcolith.

The stages in the life-history suggest very strongly a type of life-history similar to that found in the *Chrysochromulina* species that have already been studied. The large-sized *Coccolithus pelagicus* is equivalent to the large non-motile walled stage in *Chrysochromulina*: As in *Chrysochromulina*, the large *Coccolithus* divides to produce four daughter-cells, which in this case are not walled but coccolith-covered, and from which the motile Crystallolithus stage is released by the discarding of a single coccolith. Sexual reproduction has been demonstrated in some members of the first series, but so far no conclusive evidence has been obtained that it occurs in members of the second series (see, however, Schwarz, 1932).

From the study of other coccolithophorids in culture in the Plymouth culture collection, some very interesting and important facts have emerged concerning the non-motile phases in their life-histories.

Plates I and II show only a selected few of the illustrations used in my address, but Figs. 1-7, 9 and 13-21 demonstrate the form-range of stages that can be found in clonal cultures of three different coccolithophorids, *Syracosphaera carterae* Braarud and Fagerland (1946), Stosch's (1955, 1958a) *Syracosphaera* (not yet named) and Pringsheim's (1955) *Pleurochrysis scherffelii*. The non-motile stages can be matched with forms of Chrysophyceae such as *Chrysosphaera marina* Schussnig (1940), Waern's (1952) *Apistonema* sp. and *A. pyrenigerum* Pascher from the Baltic, and Anand's (1937) *Apistonema carteri*, *Chrysonema litoralis*, *Thallochrysis litoralis*, *Chrysotila stipitata and C. lamellosa* from the chrysophycean zone on the chalk cliffs near Westgate. Equivalent stages can also be found in the chrysophycean zone discovered by Dr Helen Blackler on the chalky sandstone cliffs of St. Andrews Bay, Scotland. The motile phase of each of the coccolithophorids named earlier possesses, in addition to the two acronematic flagella, a very short haptonema, previously recorded only for Stosch's organism (Figs. 1, 4). The haptonema is extremely difficult to detect and can be seen only when the motile cell is in the " naked " stage before the coccoliths are developed (cf. Figs. 2, 4). The " naked " stage, like the Crystallolithus stage of *Coccolithus pelagicus* (cf. Parke and Adams, 1960, Plate I), is covered with scales of the basic type on which are produced the coccoliths ; in these three organisms they are of the open ring type known as cricoliths (Braarud *et al.*, 1952 ; Braarud *et al.*, 1955). Unlike the *Coccolithus pelagicus* motile stage, however, these motile stages are not phagotrophic but,

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## EXPLANATION OF PLATE I

Photomicrographs of material grown in culture

(Figs. 1-8, × 1650; Figs. 9-10 × 375)

Fig. 1. Young motile cell of *Syracosphaera carterae* Braarud & Fagerl. recently liberated from the benthic stage, showing a very short, partly extended, haptonema between the two acronematic flagella ; scales covering body but cricoliths not yet developed.

Fig. 2. Mature motile cell of *Pleurochrysis scherffelii* Pringsheim with two acronematic flagella, unequal in length, and thick covering of cricoliths which mask the haptonema.

Fig. 3. Early fission stage of *P. scherffelii*, showing four flagella and a thick layer of coccoliths round the body.

Fig. 4. As Fig. 1 but of *P. scherffelii*.

Fig. 5. Non-motile stage of *P. scherffelii* before fission, anchored by the short haptonema.

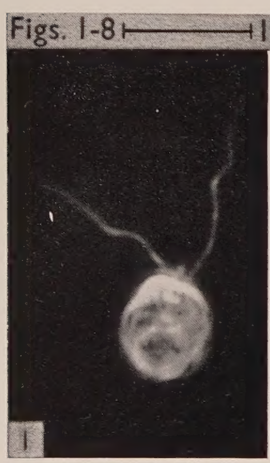
Fig. 6. *P. scherffelii* in non-motile Chrysosphaera stage, having divided into four daughter-cells after casting its cricoliths.

Fig. 7. *P. scherffelii* in non-motile Ochrosphaera stage, having retained its cricoliths and divided into four daughter-cells.

Fig. 8. Dividing cells of *Ochrosphaera neapolitana* Schussnig surrounded by coccoliths.

Fig. 9. *Syracosphaera carterae* in benthic Chrysotila stage ; treated with Schultze's solution.

Fig. 10. Cyst stages (dark round masses) of *Ochrosphaera neapolitana*.


Figs. 1-8 ⊢—⊣ 10 μ
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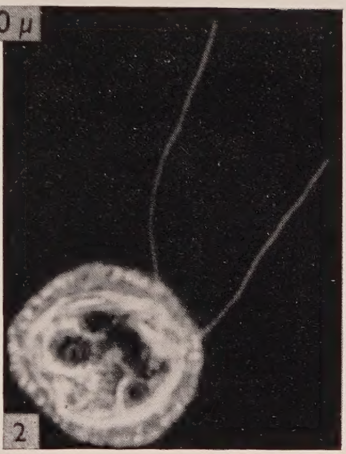
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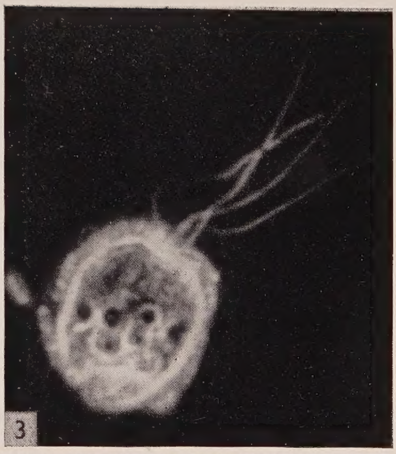
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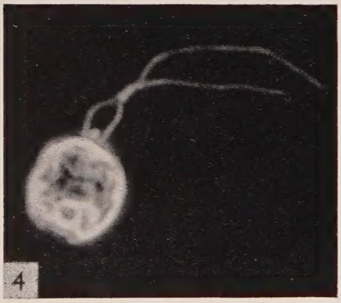
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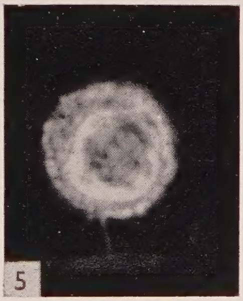
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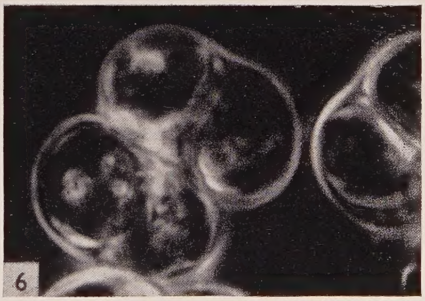
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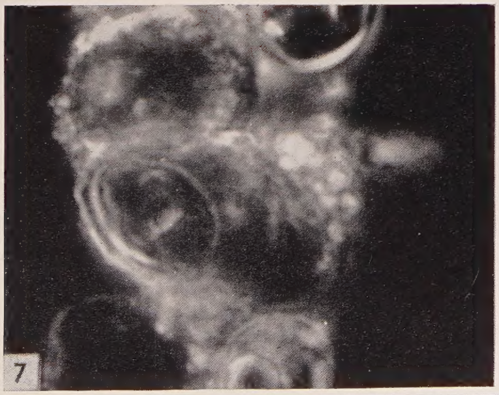
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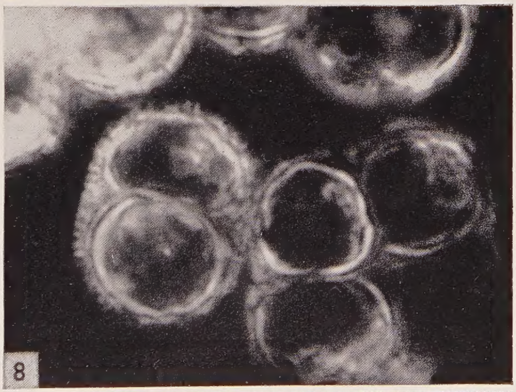
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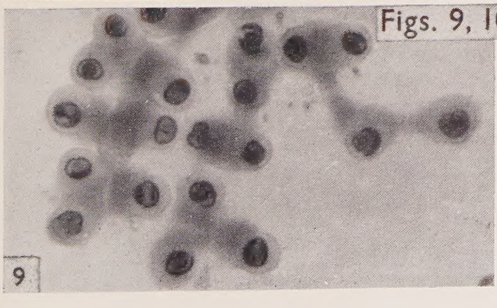
Figs. 9, 10 ⊢—⊣ 20 μ
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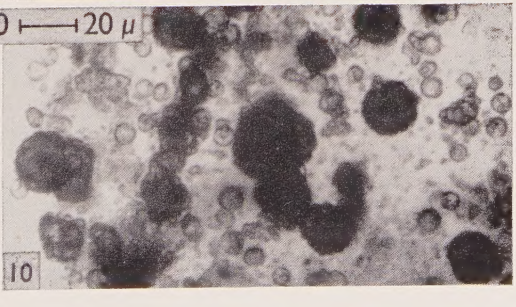
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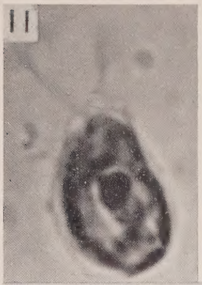
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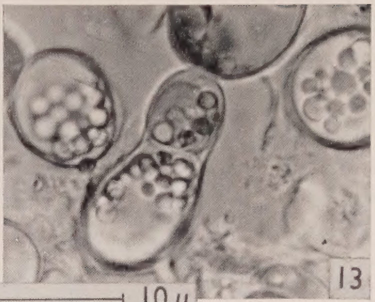
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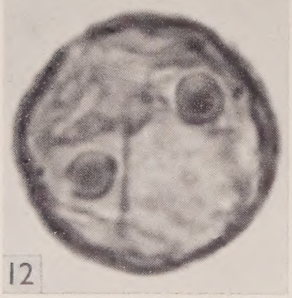
Figs. 11, 12. ⟝ 10 μ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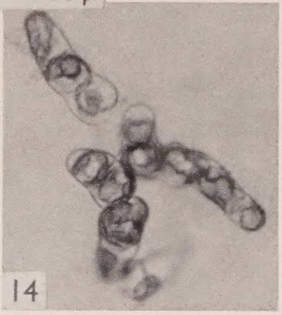
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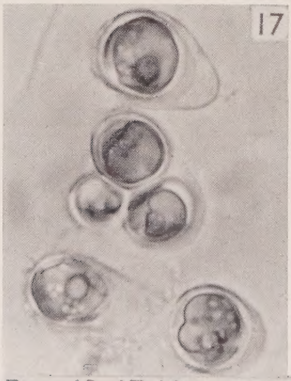
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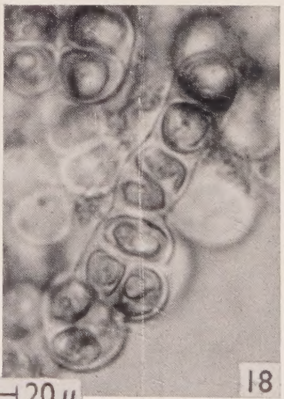
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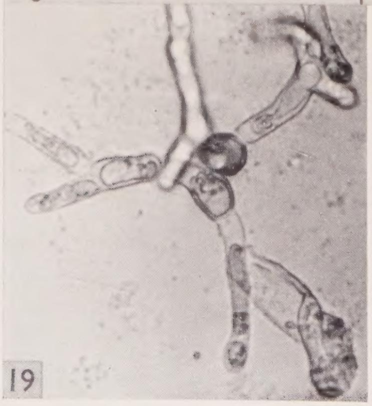
Figs. 13, 17-18 ⟝ 20 μ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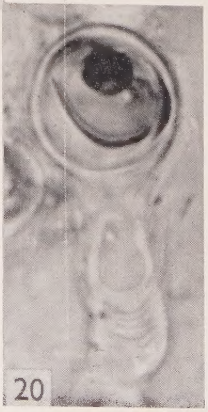
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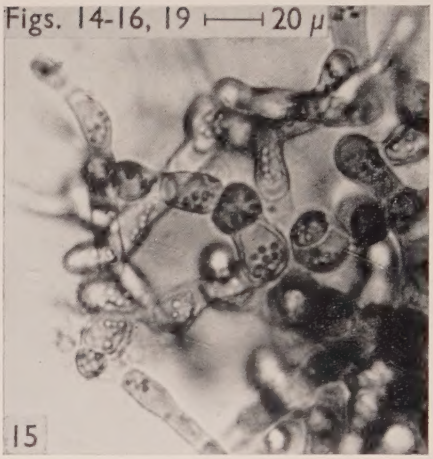
Figs. 14-16, 19 ⟝ 20 μ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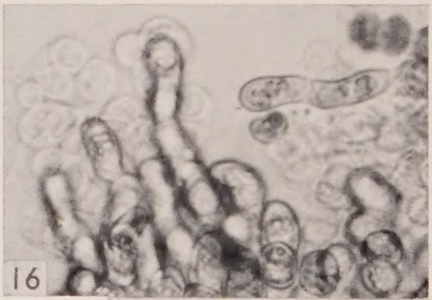
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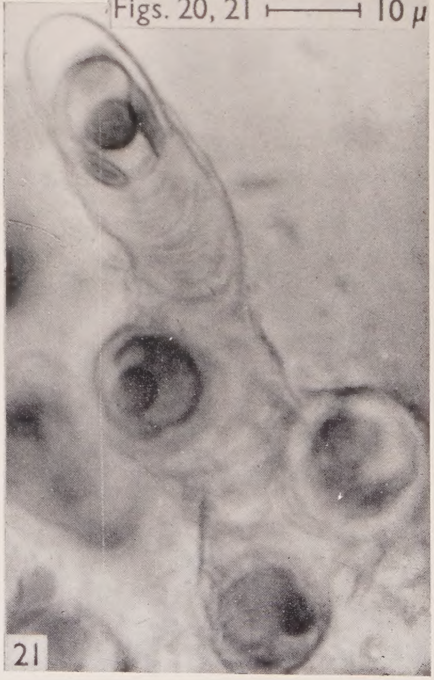
Figs. 20, 21 ⟝ 10 μ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like the Crystallolithus stage, they divide in the motile stage (Fig. 3) and can remain permanently in that stage if conditions are suitable. When cultures are left without subculturing, non-motile stages develop. Their appearance depends greatly on the length of time for which they have been in the non-motile state, and on whether they are growing free or attached, on the bottom or sides of the flask, or in or out of the culture medium. Those growing out of the medium for a long period nearly always have a thick striated wall (Fig. 17) (cf. also Lund, 1942; Waern, 1952, Figs. 34-37).

On becoming non-motile the cells can be said to be in the Ochrosphaera stage (Schussnig, 1930, 1940), and can occasionally be seen attaching by means of the haptonema (Fig. 5). Cell division then begins, the cells first become tetrads, and then either retain their coccoliths as the Ochrosphaera stage (Figs. 7, 8) or cast them to resemble Schussnig's *Chrysosphaera* species (Fig. 6). If the daughter-cells do not remain in tetrads but slide past each other to form rows and then continue to divide, they become either Nematochrysis (Fig. 14) or Thallochrysis (Fig. 18) stages. With further cell division and stretching, the Apistonema (Figs. 13, 15-17) and Chrysonema (Fig. 19) stages appear, while the Chrysotila stages develop, as in *Prasinocladus*, by the periodic contraction of the protoplast in the upward direction, followed each time by the secretion of a new membrane (Figs. 9, 20, 21). Bourrelly (1957) suggested that the form of *Apistonema pyrenigerum* sometimes recalled the dendroid colonies of *Chrysotila* (cf. Fig. 17).

The problem is now to which coccolithophorid can a particular *Apistonema* species be attached—or for that matter the other described marine forms already mentioned. One freshwater species, one freshwater or brackish species, and three marine species of *Apistonema* have been described, the species depending on the number of chromatophores and pyrenoids present per cell and on the presence or absence of a stigma in the motile stage. Anyone who has tried to identify an *Apistonema* species has come up against the same problem—the recognition of pyrenoids in the cells. Dangeard (1934), Lund (1942), Bourrelly (1948), Waern (1952) and Magne (1954) have all stated that pyrenoids are

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EXPLANATION OF PLATE II

Photomicrographs of material grown in culture

(Figs. 11-12, × 2250; Figs. 20-21, × 1200; Figs. 13, 17-18, × 750; Figs, 14-16, 19, × 375)

Fig. 11. Motile cell (9 × 6.5$\mu$) of *Ochrosphaera neapolitana*, recently liberated from the non-motile phase, showing the proximal parts of the two acronematic flagella, a large stalked pyrenoid in the centre of the body and a fine line round the body indicating the scale covering.

Fig. 12. Non-motile incipient fission stage of *O. neapolitana*, showing two large pyrenoids, one attached by a neck to inner face of a chromatophore.

Fig. 13. Apistonema stage of *Syracosphaera carterae*, showing cells full of " lipid bodies."

Fig. 14. Nematochrysis stage of *Pleurochrysis scherffelii*.

Fig. 15. Apistonema stage of *Syracosphaera carterae*, showing cells full of " lipid bodies,"; some filaments passing into the Chrysonema stage.

Fig. 16. Filaments of the Apistonema stage of *S. carterae* and empty walls of the Chrysosphaera stage from which the motile cells (Fig. 1) have been released.

Fig. 17. Gloeochrysis–Apistonema–Chrysotila stage of *S. carterae* (cf. Waern, 1952, Fig. 34).

Fig. 18. Thallochrysis stage (young) of *Pleurochrysis scherffelii*.

Fig. 19. Chrysonema stage of *Syracosphaera carterae*.

Figs. 20–21. Chrysotila stage of *S. carterae*.

difficult to see and that their presence may be inconstant. I agree with their statements concerning the difficulty of recognizing pyrenoids with the light microscope, since I have been wrong about their presence in some *Chrysochromulina* species, as Manton has shown by sectioning the material (Manton and Leedale, 1961a). Sometimes they are difficult to find in the Apistonema and other stages of certain coccolithophorids, although at other times they can be clearly recognized (Figs. 11, 12). Globules of unknown function, here referred to as " lipid bodies " for want of a better name, frequently occur in large numbers in the cells (Figs. 13, 15) and appear to arise from the inner face of the chromatophores. In such cases they can mask the pyrenoid completely (Fig. 13). One wonders if the external pyrenoids (Figs. 11, 12) are always present in the organisms for which they have been recorded (cf. Parke *et al.*, 1958, Plate VII; 1959, Plate IV). It is obvious that we need information on the chemical nature of these organelles so that a diagnostic colour reaction can be found for checking their occurrence. Another difficulty in trying to identify an Apistonema stage with a described form is the variation in the number of chromatophores per cell, since the number has been taken to be a specific character (cf. also Waern, 1952, p. 89). Bourrelly (1957) suggested that the only characters of value for distinguishing an Apistonema species might be given by the zoospores, but added that these were seen only very rarely. Although I have not yet made a detailed study or comparison of the production, release (Fig. 16) and structure of the naked stages (cf. Figs. 1 and 4) in the three species or in the St. Andrews material, from the observations that I have made they appear very similar. It may therefore be necessary to culture the motile stage (Fig. 4) until the coccoliths have been formed (Fig. 2), and then to examine the coccoliths by the electron microscope, before an Apistonema stage can be named and related to its motile phase.

So far two types of coccolithophorid life-history have been illustrated, the *Coccolithus pelagicus* type and the type with an Apistonema stage, both types possessing, in the motile phase, the characteristics of my second series. A third type of life-history may be represented by the type species of *Ochrosphaera*, *O. neapolitana* Schussnig (Figs. 8, 11, 12), described as producing gametes and zoospores of the *Ochromonas* type (Schwarz, 1932). From the single strain in the Plymouth collection no evidence of sexual reproduction has been obtained, but with the help of Professor Manton's electron micrographs it is evident that the motile stage (Fig. 11) is not of the *Ochromonas* type. Like the other coccolithophorid motile stages shown earlier, it can be placed in the second series, as it has the body covered with scales and possesses two acronematic flagella, subequal to unequal in length; unlike them, however, it remains motile for only a short period and I have as yet no evidence that it possesses a haptonema or that it can divide in the motile phase. The discovery of its cysts (Fig. 10) is of great interest, as their structure seems to place this organism close to the two little-known groups of coccolithophorids, the Thoracosphaeridae and the Discoasteridae, known only from empty cysts or separated cyst elements.

From these facts of some coccolithophorid life-histories, I suggest that the present system of classifying the coccolithophorids on the morphology of their coccoliths will prove unsatisfactory in the future. It may be that eventually the classification of the coccolithophorids within the Chrysophyceae will have to be based on their type of life-history. This may or may not run parallel with coccolith morphology, but only time—and a very great deal of hard work—will give us the answer. For example, all the inshore phototrophic coccolithophorids with cricoliths on the motile stage may produce a benthic filamentous phase, perhaps growing best on a chalky substratum on the shore (cf., however, Waern, 1952), while another series could, like *Coccolithus pelagicus*, have a phototrophic and/or phagotrophic motile phase, bearing delicate coccoliths, and a non-motile cyst stage, covered by comparatively tough coccoliths from which the motile phase is again released when conditions are suitable. A further series may have a complicated type of life-history like that recorded for *Coccolithus fragilis* Lohm. by Bernard (1948, 1949), and yet another series may have its non-motile phase endophytic in the wall strata of another alga (Waern, 1952 p. 90) or symbiotic in some animal.

Dr Lund (1959), in his presidential address two years ago, said " We shall never understand the ecology of algae without a vast amount of cultural work. We must, however, combine this with observations on populations in nature." How true are his words. From the few facts I have given you today it is obvious that all the benthic chrysophycean forms that have been described will need to be re-examined both by observations in the field and by means of cultures. It is now clear also that it is not sufficient to describe a motile stage immediately upon its release from the benthic stage; it must be followed for some time in culture to see whether or not it produces coccoliths—as occurred, for example, in *Pleurochrysis scherffelii*, and as probably occurs in the motile stage of *Chrysonephos lewisii* from the Florida Keys, since Taylor (1951, 1952) records the motile cell as being inconspicuously verrucose towards the foremost pole. Only cultures of the organism will give us the required information.

I am not suggesting that all the known marine benthic Chrysophyceae are phases of coccolithophorids; some certainly are not. For instance, the organism described by Anand (1937, Fig. 4) as *Gloeochrysis maritima*, and observed by him only in the non-motile phase, produces an Ochromonas motile stage which agrees with the description of *Ochromonas oblonga* Carter (1937). It can be phagotrophic, and it divides in the motile stage, in which it can persist indefinitely, i.e. as an *Ochromonas* species. This organism and also *Phaeocystis pouchetii* can be used to illustrate the difficulties that one encounters when trying to place many organisms within the framework of any of the systems of classification for the Chrysophyceae. Both organisms can be kept indefinitely either as the motile phase, one as an *Ochromonas* the other as a *Prymnesium*, or as the non-motile phase, the phase assumed being apparently dependent on external conditions and not controlled genetically. Should they be classified as motile forms or as non-motile forms which produce zoospores and/or gametes?

That external control of the phases is a possibility, at least for some chrysophycean forms, may be of extreme importance from the fisheries angle, particularly as food in the culture and rearing of shellfish larvae. The recorded occurrence (Braarud and Fagerland, 1946) of *Syracosphaera carterae* in such numbers as to produce a bloom in an artificial pond used for the rearing of oyster larvae at the hatchery at Flødevigen, near Arendal, South Norway, suggests that external control is not only a possibility but a probability with some forms. Much work by the physiologists will be needed, however, to find out the requirements necessary to produce the motile and non-motile phases at will. It must also be known in which organisms the phases can be controlled by external means. Time and patience will also be required to relate the many described motile phases to their non-motile stages, as well as to clear up the many nomenclatural problems that will be involved.

Magne (1957a, 1957b), summarizing most of the known records for marine benthic Chrysophyceae, shows how little knowledge we have of their existence in nature, and how justified was Pascher (1925) in his criticism of marine algological investigations which ignored these forms. Since Pascher's criticism there has been an "awareness" of the benthic Chrysophyceae by some workers in the marine field, but by many ecological workers they have been and still are, completely ignored.

I hope that I have given some slight idea of the enormous amount of exciting work that is waiting to be done on members of the Chrysophyceae. I have suggested that there may be two distinct series grouped in this class, one series with affinities towards the diatoms and the other related more closely to some, if not to all, of the coccolithophorids. The data, of course, are at present too fragmentary to enable any firm proposals to be made on classification in the class, but they certainly suggest that further work may clarify our understanding of it. I sincerely hope that before I retire some of our young members will be working on this class and will be able to tell our Society whether the suggestions which I have made today have turned out right or wrong.

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# SOME NEW AND UNCOMMON BRITISH VOLVOCALES

by

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## Abstract

British material of the following algae is described: *Pyramimonas tetrarhynchus* Schmarda; *Spermatozopsis exsultans* Korshikov; *Myochloris collorhynchus* nov. gen. et sp.; *Pedinomonas minor* Korshikov; *Monomastix opisthostigma* Scherffel; *Lobomonas ampla* Pascher var. *okensis* Korshikov; *L. rostrata* Hazen; *Diplostauron pentagonium* (Hazen) Pascher; *Phacotus lendneri* Chodat; *Chlorobrachis* sp.

*Pyramimonas tetrarhynchus* Schmarda (Fig. 1, A,B,C,D).

In April 1960 large numbers of cells of this species were present in a pool at Skelwith Fold, Ambleside, and a few were seen there the following spring. Several individuals were also collected from a pool on Tarn Moss, Malham, Yorkshire, in August 1960. This species has apparently not been recorded from Britain. Pascher (1921) and Geitler (1925) give descriptions of it.

The cells of the Skelwith material were up to 23$\mu$ in length and 18$\mu$ in breadth, with four thick flagella up to 35$\mu$ long. Each cell had a four-lobed chromatophore with the lobes further deeply divided, a large pyrenoid with starch sheath, and a pair of elongated eye-spots opposite each other on adjacent lobes of the chromatophore. A row of starch grains was present in each of the lobes (Fig. 1, A,B).

Cells in all stages of division were found, agreeing with those described by Geitler (1925). Both pyrenoid and chromatophore divide into two longitudinally in a plane between the eye-spots, each half cell taking two of the chromatophore lobes, which soon become four by the extension of the slits in the anterior parts of the lobes. The eye-spots become duplicated on the opposite side of the cell, so that each daughter-cell has two which become adjacent as the rift in the chromatophore left by division closes to a slit. The new flagella grow out beside the old ones while the cell is dividing (Fig. 1, C,D).

*Spermatozopsis exsultans* Korshikov (Fig. 1, G,H,I). (Mis-spelt "exultans" by Pascher (1927) and others.)

*Spermatozopsis* was first noticed in an enrichment culture of water from Dobb's Weir on the River Lee, Hertfordshire, in September, 1959. Subsequently it occurred occasionally in other cultures.

In this material each individual had four flagella, except when a cell was about to divide, when eight were present. The cells divided longitudinally into two, confirming Korshikov's original description (1913) and not supporting Pascher's idea that the quadriflagellate cells may be zygotes (Pascher, 1927). An eye-spot could not be seen with certainty. The cells were 9-10$\mu$ in length.

The alga has been obtained on several occasions during the summer of 1960 from the Kendal Canal at Tewitfield, Lancashire, and was also collected from a pool on Great Close Mire, Malham, in August, 1960.

There have been three previous records of *Spermatozopsis* in Britain: in a pond near Chester (Williams, 1933), from pools in Richmond Park (Lund, 1942), and in bomb crater pools in Epping Forest (Scourfield, 1944). On all these occasions the alga was present only in small numbers.

*Myochloris* nov. gen. (Fig. 1, J–R.)

Cellula ovoidea, dorsiventralis, ventraliter compressa; polo anteriori rostriformiter curvato, interdum similis proboscidi extendens; flagella bina inaequalia, sub apice sublateraliter inserta; chromatophoro viridi dorsuali parietali, cum 1-3 pyrenoidibus; stigmate rubro in parte dorsuale cellulae; vacuolo contractilii antice sub apice locatum; nucleo plusminusve centraliter sito.

*M. collorhynchus* nov. sp.

Characteribus generis. Cellulae 7–9$\mu$ × 4–7$\mu$. In lacunis in vestigiis vaccarum, Great Close Mire, Malham, Yorkshire.

Cells dorsiventral, oval, flattened ventrally, with the anterior end drawn out into a small ventral extensible and adhesive point. Flagella two, one two-thirds the length of the other, attached to the ventral surface about one-third of the body length behind the anterior end, generally on the right-hand side. Chromatophore bright green, parietal, dorsal and occupying roughly two-thirds of the cell. Pyrenoids one to three, with starch sheaths. Anterior contractile vacuole. Red eye-spot on dorsal surface of chromatophore. Nucleus central, below the chromatophore. Cells 7–9$\mu$ long and 4–7$\mu$ wide.

Reproduction by division into two daughter-cells. Only the beginning of this has been seen (Fig. 1, N) and further details are unknown.

The organism has a characteristic darting movement and often revolves on its axis when swimming freely. In motion, the longer flagellum trails behind in the longitudinal axis, while the shorter is held laterally.

Cells frequently attached themselves temporarily to the substratum by means of an extensible proboscis put out from the pointed end. Thus fixed, the cell sometimes moved vigorously round the point of attachment for some time (Fig. 1, J and Q). The former of these figures shows a cell attached downwards to a glass slide and the latter one attached upwards to a cover-slip.

*Myochloris* was first seen from a small temporary puddle of water collected in a cow's hoof-print, on Great Close Mire, Malham, Yorkshire, in August 1960. Shortly afterwards it was found again among weeds from the Kendal Canal at Tewitfield.

This species seems to belong to the Volvocales on account of its bright green chromatophore, pyrenoids with starch sheaths, and red eye-spot. As the cells are apparently naked it must be included in the family Polyblepharidaceae (Fritsch, 1935) which contains two rather similar genera, *Trichloris* and *Dangeardinella*. Pascher's *Trichloris* has similarly shaped dorsiventral cells and similar cell contents, but has three sub-apical flagella (two short and one long) and no apical prolongation. *Dangeardinella* (Pascher, 1930) has an

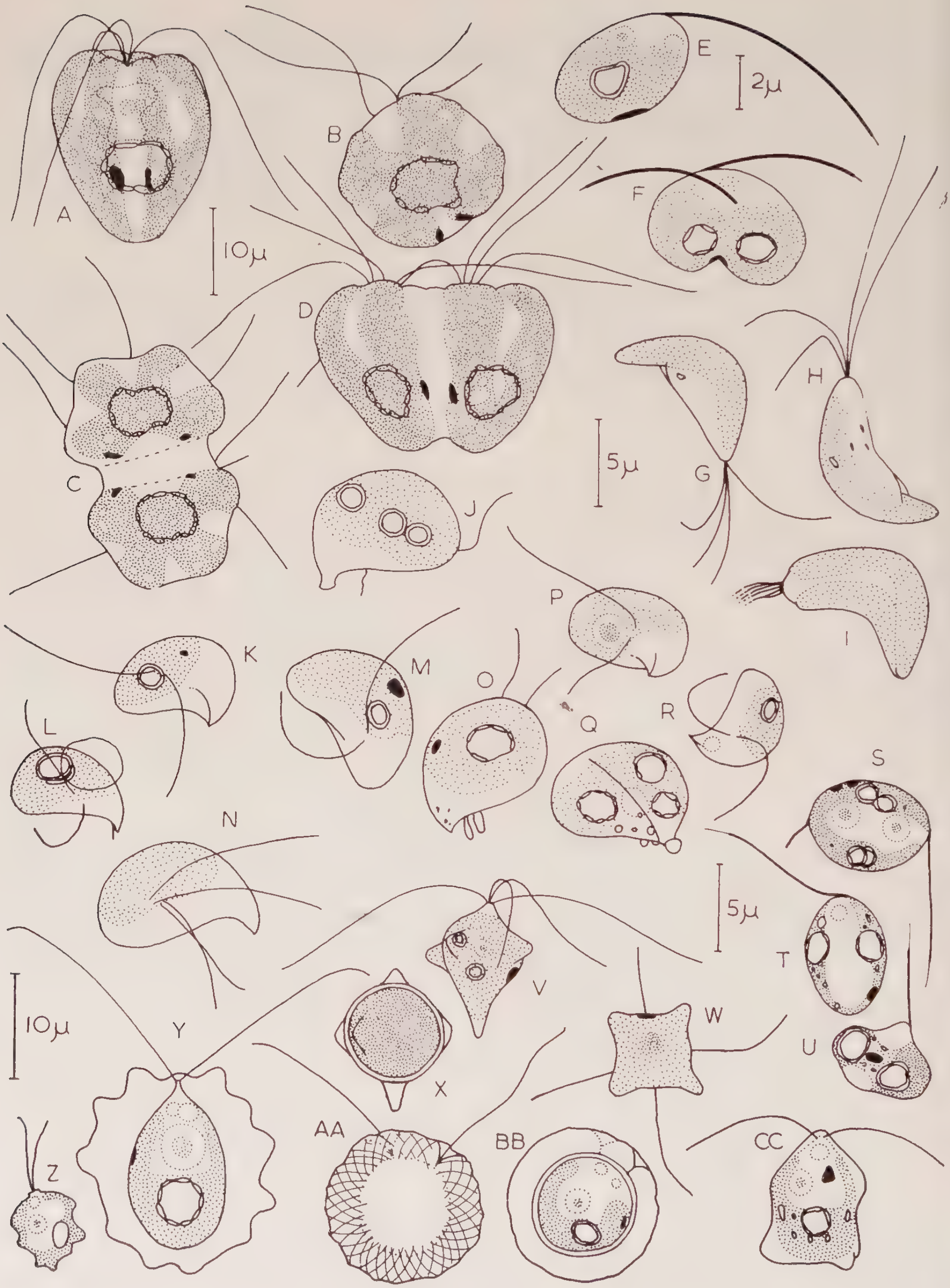

Figure 1.

elongated colourless anterior end, is dorsiventral, and has two equal sub-apical flagella, one of which points forwards and the other backwards.

*Pedinomonas minor* Korshikov (Fig. 1, E,F).

This alga was first described by Korshikov (1923), who states that it is very common in dirty water. On several occasions during the summer of 1960 it was collected from the Kendal Canal at Tewitfield. It has also been found in the hoof-prints of cattle on Great Close Mire, Malham, and in farm puddles at Near Sawrey, Lancashire.

Material from the canal (Fig. 1, E) was observed in culture, and division (Fig. 1, F) and palmella stages were seen, closely resembling those given by Korshikov (1923). No sexual stages were found. Incidentally, some of Korshikov's figures reproduced by Pascher (1927, Fig. 75, Nos. 4 and 5) and stated to be copulating gametes are really division stages according to the original paper.

*Pedinomonas minor* usually swims backwards. When swimming, the flagellum moves at each stroke so as to be first extended in a straight line in front of the organism and then curved downwards towards the surface bearing the eye-spot. When not in motion, the flagellum often lies closely along this surface and becomes invisible.

This alga has been recorded once before from Britain (Williams, 1933), but it was not illustrated.

*Monomastix opisthostigma* Scherffel (Fig. 1, S,T,U).

A small form of this species was collected from temporary pools on the limestone pavement above Malham Tarn in August 1960. Subsequently it has been found in similar pools on Scout Scar, Lancashire, several times in the Kendal Canal at Tewitfield, and in a nitrogenous puddle on a farm at Near Sawrey, Lancashire. There does not seem to be any previous record for *Monomastix* in Britain.

Cells (Fig. 1, T,U) measured up to 9$\mu$ long and 6$\mu$ wide and each had a flagellum not more than 9$\mu$ in length, with a pronounced " whiplash " end sometimes nearly 3$\mu$ long. The flattened oval cells had a single U-shaped chromatophore containing two pyrenoids with starch sheaths. One of these was placed half-way along each limb of the

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Fig. 1. A,B,C,D, *Pyramimonas tetrarhynchus* from Malham; A,B, side and basal views of vegetative cells; C,D, dividing cells. E,F, *Pedinomonas minor* from Tewitfield; E, vegetative cell; F, division. G,H,I, *Spermatozopsis exsultans* from River Lee; G,H, vegetative cells; I, dividing cell. J–R, *Myochloris collorhynchus* from Malham; all except N are vegetative cells, J and Q attached to glass slides by anterior end; N, beginning of cell division. S,T,U, *Monomastix opisthostigma* from Malham; S, dividing cell; T, vegetative cell; U, basal view. V, W,X, *Chlorobrachis* sp. from Malham; V, vegetative cell; W, basal view; X, cyst formation. Y, *Lobomonas ampla* var. *okensis* from Tewitfield. Z, *Lobomonas rostrata* from River Lee. AA,BB, *Phacotus lendneri* from Malham; AA, external sculpturing; BB, cell contents. CC, *Diplostauron pentagonium* from Malham. J,Q,R,S,T and Y were drawn alive, the remainder being fixed with osmic acid vapour and drawn immediately. Magnifications: A–D,V,W,X, × 1,300; E,F, × 4,000; G–U,CC, × 2,600; Y,Z,AA,BB, × 1,600.

chromatophore. At the base of the cell was a prominent red eye-spot, and at the apex a contractile vacuole. The cells swam backwards and forwards with a curious tumbling motion. One cell (Fig. 1, S) was seen undergoing transverse division, with a flagellum at each end, four pyrenoids, two eye-spots and two nuclei.

In his original description Scherffel (1912) gives a size range of 6–22μ in length and 3–8μ in breadth. The present material fits in with the lower part of this range, though it may be identical with *Monomastix minuta* of Skuja (1956), 7-12μ long, which is apparently quite similar to Scherffel's smaller individuals.

Particularly in his larger ones, Scherffel describes refractive rods, 1μ by 4μ. In only one cell of the British material was there the faintest indication of rod-like bodies.

There is some doubt as to the affinities of *Monomastix*. Scherffel (1912) and Korshikov (1938) include it with the Volvocales, while Fritsch (1935) classes it in the Cryptophyceae and Skuja (1956) places it among the Chloromonadineae. The bright green colour of the chromatophore, the pyrenoids with starch sheaths, the presence of an eye-spot, the " whiplash " flagellum and the absence of a gullet are evidence for its inclusion in the Chlorophyceae.

*Lobomonas ampla* Pascher var. *okensis* Korshikov (Fig. 1, Y).

A form closely resembling this appeaared in an enrichment culture of River Lee water from Dobb's Weir collected in September 1959. The cells agreed with Korshikov's description (1938) and were a little over 20μ in length.

This alga has also been found in an enrichment culture from the Kendal Canal at Tewitfield in June 1960.

It has not been previously recorded from Britain.

*Lobomonas rostrata* Hazen (Fig. 1, Z).

This alga appeared in an enrichment culture of water from the River Lee at Broxbourne, Hertfordshire, in August 1959. Vegetative cells seemed similar to those figured by Hazen (1922), the characteristic papilla being very evident. The size range of 5.8–8μ agreed with Hazen's 5–12μ. No reproductive stages were seen in the material.

It has also been found on several occasions in the Kendal Canal at Tewitfield during the summer of 1960, and once in a hoof-print puddle on Great Close Mire, Malham.

Apparently there is no previous record of the alga for Britain. Pascher (1927) says " Bislang aus England, in Regenwasser-pfutzen " but this seems to be a mistaken reference to New England in connexion with Hazen's records of another species from Vermont and New Jersey.

*Diplostauron pentagonium* (Hazen) Pascher (Pascher, 1927) (Fig. 1, CC).

This species was first described from Ham Common, Surrey, by Hazen (1922), as *Lobomonas pentagonia*, and was also found by Jane (1938) at Shenley, Hertfordshire.

In August 1960, large numbers were found in a shallow muddy pool on Tarn Moss, Malham. The chromatophore and pyrenoid varied in position from basal to lateral, and the eye-spot was triangular to oval. From the side, the cells appeared pentagonal, whereas in basal view they were three to five-sided.

*Phacotus lendneri* Chodat (Fig. 1, AA, BB).

This species was described from Switzerland by Chodat (1902, p. 147), who distinguished it from *P. lenticularis* (Ehrenberg) Stein by the spiral markings on the valves. Pascher (1927) thought that the two were indistinguishable. *P. lendneri* has apparently not been recorded from Britain.

Both species were common in the plankton of Malham Tarn during August 1960 and the cells of *P. lendneri* clearly showed the spiral sculpturing of the envelope, which had two conical apertures about 5μ apart for the passage of the flagella. This feature was not mentioned by Chodat in his diagnosis, nor was the central position of the protoplast within the wall, although these are shown in his illustration, and further serve to distinguish the species from *P. lenticularis*.

No cell contents were shown by Chodat, but the cells from the tarn closely resembled *P. lenticularis* in having a cup-shaped chromatophore, single pyrenoid, lateral eye-spot and two contractile vacuoles (Fig. 1, BB).

*Chlorobrachis* sp. (Fig. 1, V,W,X)

In August 1960 cells of an organism apparently belonging to this genus were found in a puddle formed in a hoof-print on Great Close Mire, Malham. A sample of mud and water, to which was added a small pea, was cultured in the laboratory, and large numbers of the alga appeared. Also in the culture was *Pyrobotrys gracilis* Korshikov, a few individuals of which had been seen in the initial collection.

The cells (Fig. 1, V,W) reached a size of 17μ, and were quadriflagellate. Both apex and base were drawn out and four pointed arms protruded from the cells transversely. There was a massive, cup-shaped chromatophore, filling the arms but not extending completely into the base of the cell. An eye-spot lay between two of the arms, and each cell contained several pyrenoids, unlike Korshikov's *C. gracillima* which had none. Two apical contractile vacuoles were seen.

Reproduction has not been observed. Some cells formed thick-walled cysts (Fig. 1, X), as have been seen in *Brachiomonas* (Gabriel, 1925).

The genus was described by Korshikov (1925), with one species, *C. gracillima*. Korshikov (1938), however, states that *C. gracillima* is the zygote of *Pyrobotrys gracilis* Korshikov. The zygote is described as being round at first, then spindle-shaped and finally has " four obtuse appendages located crosswise." It remains in this state for many days and eventually rounds off to form a spherical resting stage. He did not observe germination of the resting spore.

There has been some confusion in the reproduction of Korshikov's original figures of *C. gracillima* in Smith (1950). Here the organism is drawn to appear flat in face view, with the four appendages emerging in the same plane as the base and apex. Also the outline drawing of the young spindle-shaped cell is labelled " side-view."

The finding of what would seem to be another species of *Chlorobrachis* appears to substantiate the independence of the genus as distinct from *Pyrobotrys*. In the Malham material the presence of pyrenoids, which were absent in the associated *Pyrobotrys*. establishes its separate status.

We would like to thank Dr J. W. G. Lund for his advice.

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# *ASTERIONELLA FORMOSA* HASS. VAR. *ACAROIDES* LEMM. A PHYCOLOGICAL ENIGMA

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This variety seems to differ from *Asterionella formosa* var. *formosa* (this name is used in the sense of *A. formosa* Hass. of Hustedt 1931–35; the correct name is uncertain) solely in the curvature of the cells (Lemmermann, 1903 p. 120). Apparently it has always been found with var. *formosa*, so that it is not surprising that its validity has been questioned (Hustedt, 1931–35; Huber–Pestalozzi, 1942; Sieminska, 1951; Pork and Pork, 1958). The British records are all from Ireland (Round and Brook, 1959, p. 188, table I; in four or six loughs). In general it seems to favour eutrophic and calcareous lakes and pools. Mr D. Cannon found it in samples from Malham Tarn, Yorkshire in 1959. These had been fixed in Lugol's solution in the field and by the time they were discovered var. *acaroides* was no longer present in the tarn. However, as a series of plankton samples was available, some observations on the rise and fall of the population in the presence of var. *formosa* could be made.

Quantitative estimations of the abundance of *Asterionella formosa* in Malham Tarn have been made at approximately weekly or fortnightly intervals, provided ice-cover was absent, from 1949–1953 and 1958–1960. During these eight years var. *acaroides* was only present between July 15th and 29th, 1959. The rise and fall of the population of var. *acaroides* was so rapid, its replacement by var. *formosa* so sudden and the course of the development of the combined populations so regular (Fig. 2) that it seems that the former is an abnormal stage or a phase in the development of the latter. Further, some colonies (Fig. 1, C,D) had both straight and curved cells, a feature previously noted by Sieminska (1951). There was sufficient material to make some possible suggestions about the nature of these curved cells.

The means by which *Asterionella* overcomes the diminution in size common to most diatom populations as they multiply is unknown. There are cyclic changes in the average size of the cells similar to those recorded for many other diatoms (concerning *Asterionella*, see Wesenberg-Lund, 1908). Observations on weekly samples from Windermere and nearby lakes covering the last sixteen years, on fortnightly ones covering the last twenty-six years and on a series of varying length and frequency for the last fifty-seven years show that these cyclic changes take place in several lakes in the English Lake District. *Asterionella* occurs in innumerable lakes all over the northern hemisphere. Millions of cells have been observed but no auxospores have been seen. This may lead to the view that auxospores are not formed and the increase in length is produced in some other unknown manner, but for this too there is no evidence. It is particularly among the freshwater pennate diatoms belonging to the Araphideae that information is lacking. Auxospores are not recorded for the very common *Tabellaria flocculosa* var. *asterionelloides* (Grun) Knuds. (*T. fenestrata* var. *asterionelloides* Grun of most authors), and for several plankton species and varieties of *Synedra*. It is only recently that they have been found in *Fragilaria crotonensis* Kitton (Nipkow, 1953).

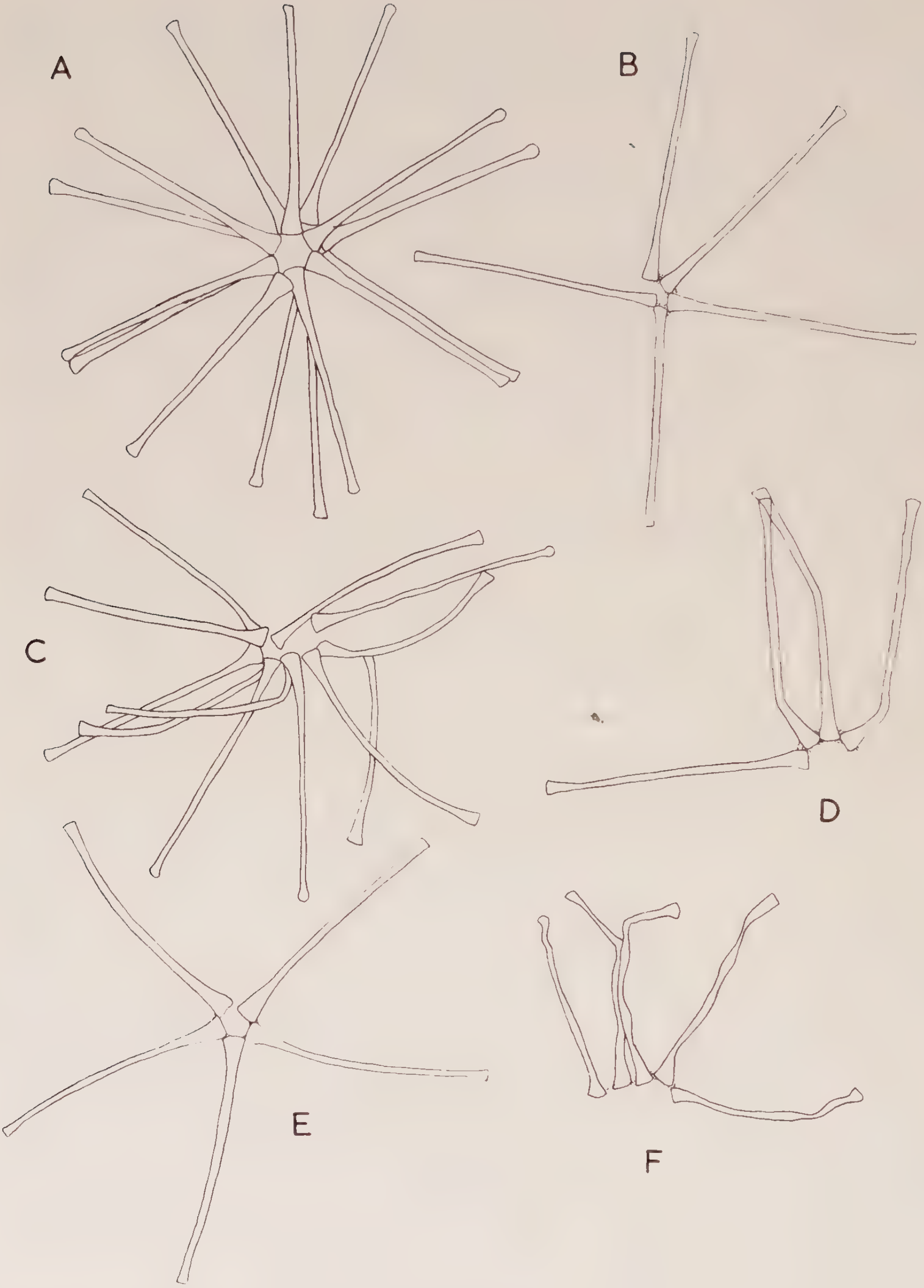

Figure 1. *Asterionella formosa*, colonies from Malham Tarn, July 22nd, 1959, of normal shape (*A*, *B*), with both straight and curved cells (*C*, *D*) and with curved or distorted cells (*E*, *F*). Only outlines drawn. From material in Lugol's solution. All × 525.

It is characteristic of auxospore formation that the spore itself and the succeeding one or two generations consist of cells which may not be fully silicified and, in consequence, are often of irregular shape (e.g. Nipkow, 1953, Abb. 5). It seemed, therefore, possible that var. *acaroides* is the auxospore stage of *A. formosa*. The cells are not only curved but also can be of irregular shape (Fig. 1, F). Their walls appear to be thin and delicate, the cells often breaking during mounting. However, there are several facts which do not support this view. No apparently naked cells were seen. The walls of *Asterionella* are so thin that no accurate measurements are possible with a light microscope. No estimations of the amount of silica present were possible because of the small amount of material and the relatively large amount of detritus, including other diatoms. The ease with which the cells are broken may be not because they are so thin but because the colonies with curved and twisted cells are less flat than the normal ones, and so more likely to be crushed during manipulation and mounting. A visual test was carried out by drying material on a cover-glass, adding 100 vol. $H_2O_2$ and heating on a metal plate. The cell walls of var. *acaroides*

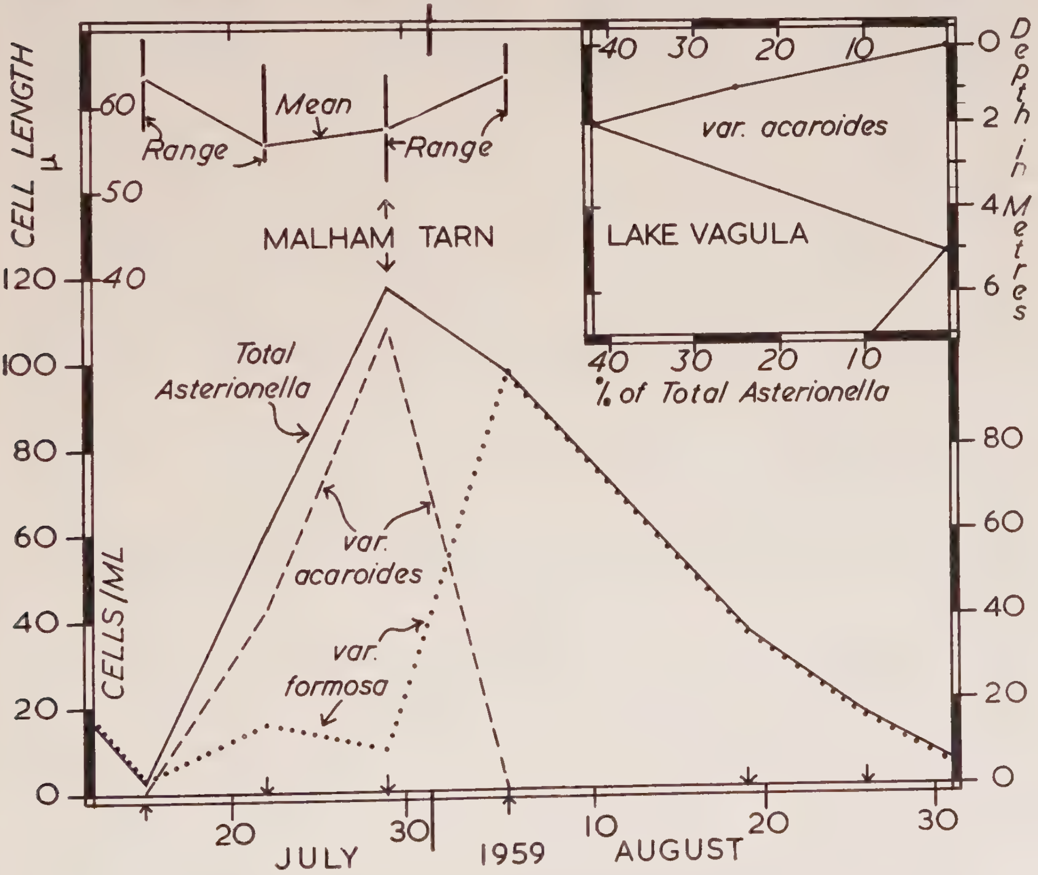

Figure 2. Changes in the abundance and in the length of the cells of *Asterionella formosa*, var. *formosa* and var. *acaroides* in Malham Tarn. Also (top, right), variations in the relative abundance of var. *acaroides* in a population of *A. formosa* in Lake Vagula, Esthonia, plotted from the data in Pork and Pork (1958).

were not destroyed, but when the coverglasses were mounted in naphrax and examined under an oil immersion their thinness was clear. The cells of most but not all the colonies of var. *formosa* in the weeks preceding and succeeding the *acaroides* phase had thicker walls.

No cells were seen which, by their size, nakedness and relation to nearby empty valves, could be thought to be auxospores. Despite the vast amount of work done on *Asterionella formosa* since 1932 by eighteen people at the Windermere laboratory of the Freshwater Biological Association, no *acaroides* stages have been seen in any lake or culture. This evidence must, of course, be treated with some caution until the taxonomy of *Asterionella* has been settled, but it does suggest that the cyclical changes in size in these lakes do not involve an *acaroides* stage.

If auxospores are produced, the succeeding cells should be markedly longer so that both the average and the range of cell length will increase. Measurements made on the Malham population (Fig. 2, top, left) show that there was a diminution in length during the period when var. *acaroides* was dominant, with an increase afterwards. Yet the average length of the cells afterwards was almost exactly the same as before the *acaroides* cells appeared. No cells exceeding $70\mu$ long were seen. In Windermere and other lakes, cells of from about $70\mu$ l to $90\mu$ l arise when there is a clear increase in the mean cell length of the population.

Sieminska (1951) suggests that the *acaroides* cells in her population may have been monstrosities induced by the injurious effect of the large population of planktonic blue-green algae present. Pork and Pork (1958) also consider such cells to be abnormal though they do not suggest a reason for their appearance. They found that the abundance of var. *acaroides* varied markedly with depth (Fig. 2, top, right). This could represent sinking populations of cells which also had been harmed by the presence of a bloom of blue-green algae. However, in Malham the *acaroides* cells appeared when blue-green algae were few in number. The dominant genera were *Sphaerocystis* and *Oocystis* and these too were not abundant.

The nature of var. *acaroides* remains, therefore, uncertain. This note is published in the hope that it will lead to more observations on this alga and a further search for the auxospores of *Asterionella*.

My thanks are due to Mr D. Cannon for assistance, and Mr P. F. Holmes and other members of the staff of the Malham Tarn Field Centre who collected the samples.

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# A CRITICAL SURVEY OF THE EVIDENCE FOR THE OCCURRENCE OF *GELIDIUM TORULOSUM* KÜTZ. AND *G. MELANOIDEUM* SCHOUSB. EX BORN. IN BRITAIN AND IRELAND

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The identification of specimens of *Gelidium*, described by Bornet as "genre diabolique," is notoriously difficult. The extreme seasonal and environmental variations in the form of the thalli are responsible for many of the difficulties, although the reluctance of phycologists to refer back to authentic material means that the application of names is very confused and information relating to geographical distribution highly unreliable. In a recent publication (Dixon, 1958a) it was shown that *Gelidium sesquipedale*, a species for which the northern limit of distribution was in doubt, did extend northwards to the coast of Devon. The present paper is concerned with two further species, *G. torulosum* Kütz. and *G. melanoideum* Schousb. ex Born., for which the evidence relating to their occurrence in Britain and Ireland is in need of clarification.

*Gelidium torulosum* Kütz.

*G. torulosum* was described by Kützing (1868) on the basis of material supplied by A. von Chamisso from Brazil. This material consisted of two specimens, the larger of which was figured by Kützing (1868, pl. 57), now preserved at the Rijksherbarium, Leyden [Herb. Lugd. Bat. 941.45.43]. The species was listed by both Martens (1870) and Piconne (1886, 1889), although De Toni (1897), who cited *G. torulosum* among his "species inquirendae," appears to have been unaware of these later records in that he quotes only the original description. Lyle (1920) first reported *G. torulosum* for the British Isles, based upon a single specimen collected by her in Guernsey. Subsequently, De Toni (1924) and Newton (1931) accepted Lyle's record with *G. torulosum* cited as a "species inquirenda," an opinion expressed also by Taylor (1960) in a recent publication. Even after examination of the original material of *G. torulosum* Kütz. it is not possible to comment on the identity of this South American alga. From the remarks made by Lyle, it is clear that she had not examined the original material but merely the description and illustration given by Kützing. To refer to this taxon a single specimen, in a genus so notoriously polymorphic as *Gelidium*, collected some 4000 miles from the original locality, is an action to be deprecated. The specimen collected by Lyle, which was figured by her (Lyle, 1920, fig. 3), is now preserved in the herbarium of the British Museum (Natural History). This specimen is nothing more than a narrow, aberrant example of the alga known generally as *G. latifolium* (Grev.) Born. et Thur.

*Gelidium melanoideum* Schousb. ex Born.

This taxon was first detected by Schousboe and, although a description and illustration were prepared by him, the alga was not formally described until Bornet (1892) published analyses of Schousboe's algae. As Feldmann (1939) has stated, the description given by Bornet is poor and it is curious that he makes no mention of the distribution of tetrasporangia, a feature indicated clearly in the Schousboe illustration.

Batters (1902) first included the species in the British flora, listing it from " Sussex (Hastings) and Northumberland (Alnmouth)," whilst Newton (1931) added to these an additional locality, Dorset ; no records other than these are known. The original material on which these records were based is now preserved in the Herbarium of the British Museum (Natural History) ; it consists of:—

1. Two specimens, both inscribed " Hastings 7th April 1883," in Batters's hand.
2. One small sheet, with a number of specimens, labelled " leg. A. Amory Berling Car Alnmouth Oct. 1885," in Batters's hand.
3. Two large sheets, each with a number of specimens, labelled " leg. E. Batters Studland Aug. 1894 " and " leg. E. Batters Studland Bay Aug. 1894," in Batters's hand, respectively, and a small sheet, with a single specimen, labelled " E. B. Studland 8/94," also in Batters's hand, which, from its appearance, is probably a fragment from one of the former.

The specimens referred by Batters to *G. melanoideum* were identified on the basis of the inadequate description published by Bornet ; these identifications have been questioned by Feldmann (1939) who stated : "l'existence de cette algue en Angleterre, où elle a été signalée par Batters, me paraît douteuse et mériterait d'être vérifiée." In order to decide whether *G. melanoideum* can be accepted as an indigenous species it is necessary to consider, firstly, whether the specimens referred by Batters to this taxon are correctly identified and, secondly, whether there are any new data indicative of its occurrence in Britain and Ireland. These two considerations both necessitate an analysis of the diagnostic features of *G. melanoideum* and a study of the differences between it and *G. pusillum* and *G. crinale*, the species with which it is likely to be confused.

According to Feldmann and Hamel (1936), the distinguishing features of *G. melanoideum* are the blackish-violet colour, the sparse occurrence of intercellular filaments (or " rhizines ") and the " V "-shaped distribution of tetrasporangia. Apart from the Batters records under consideration, the taxon has been reported only from the western Mediterranean and the Atlantic coast of North Africa. Feldmann and Hamel make no mention of the occurrence of intergrades between *G. melanoideum*, on the one hand, and *G. crinale* and *G. pusillum*, on the other, although it appeared from the fieldwork carried out during the past two decades that the features regarded by Feldmann and Hamel as characteristic of *G. melanoideum* may occur, although very infrequently, in the two latter entities in Britain and Ireland. This opinion was reached without personal knowledge of *G. melanoideum*, but the opportunity to examine this species in the field, during visits to Banyuls, has indicated that on the Côte des Albères *G. melanoideum* is distinct from the entities of the *G. crinale/pusillum* assemblage. The previous opinion clearly resulted from the misinterpretation of imprecise descriptions.

Firstly, with regard to colour, specimens of *G. crinale* and *G. pusillum* are red, brown or golden-yellow although occasionally dark-coloured when growing in situations where the light intensity is much reduced. Comparison of these dark-coloured specimens with specimens of *G. melanoideum* indicates that there is a slight, but very characteristic, difference in colour in living material. Without means of comparison, it is difficult to assign a living specimen to the correct category, and in the case of herbarium specimens almost impossible. Thus, although there is a distinct colour difference between *G. melanoideum* and the dark-coloured specimens of the *G. crinale/pusillum* assemblage, this is not sufficiently distinct for use as a taxonomic criterion under field conditions.

The distribution of intercellular filaments in *G. crinale* and *G. pusillum* has been shown to be particularly variable, with regard to both number and distribution (Dixon, 1958b). There is, however, a marked difference in the number of intercellular filaments between *G. melanoideum* and the *G. crinale/pusillum* assemblage. The number of filaments in the axes of *G. melanoideum* is indeed very low, lower than the number to be expected from the literature and much lower than the number to be found in even the most depauperate specimen of the *G. crinale/pusillum* series. Thus, there is no difficulty in distinguishing between *G. melanoideum* and other species of the genus on the basis of this feature.

The situation relating to the distribution of tetrasporangia is a little more complex. In most species of *Gelidium* the arrangement is haphazard, although a " V "-shaped pattern of sporangia has been reported in *G. melanoideum* and some other species (c.f. *G. calo-glossoides* Howe, 1914), as well as in the closely related genera *Gelidiella* and *Pterocladia*, where Moore (1945) has commented on the occasional " V "-shaped arrangement of tetrasporangia in *Pt. capillacea*, and where Taylor (1943) has described two species, *Pt. americana* and *Pt. bartlettii*, characterised by this feature. In addition, a partial or almost complete " V "-shaped distribution of tetrasporangia has been detected in specimens otherwise referable to *G. crinale* or *G. pusillum* collected at Ardfry (Co. Galway), Black Head (Co. Clare), Lough Ine (Co. Cork), Dungarvon (Co. Waterford), Borth Saint (Holy Island, Anglesey), Rhosneigr (Anglesey), Salcombe (Devon), and Sark (Channel Islands), whilst the same phenomenon has been detected in specimens of *G. latifolium* collected at Porth-y-Garron (Holy Island, Anglesey) and Chapman's Pool (Dorset). The presence of such a characteristic arrangement of tetrasporangia was the principal reason for the initial doubts as to the limits of *G. melanoideum* and the *G. crinale/pusillum* complex. Investigation has shown that, in the genera *Gelidium*, *Gelidiella* and *Pterocladia*, the arrangement of tetrasporangia is a reflection of the distribution of cortical cells. The apical segmentation, which in *Gelidium* has been discussed previously in some detail (Dixon, 1958b), is such that four pericentral cells are formed from each segment produced by the transverse division of a principal apical cell. The four pericentral cells, inclined to the axial filament at an angle of 30°, give rise to filaments of limited growth, which, by their aggregation, produce the cortex of the axis. In *Gelidiella* and *Gelidium melanoideum*, the inclination of the pericentral cells is retained by the filaments of limited growth so that their apical cells, which form the superficial layer of the cortex, are orientated in a " V "-shaped pattern which persists almost indefinitely. In *Pterocladia capillacea* and most species of *Gelidium*, the characteristic arrangement of the cortical cells is quickly lost, being observable only for a short distance behind the apical cell, although in a few specimens it may be retained for a greater distance. The retention of the " V "-shaped arrangement of the cortical cells in these species appears to be correlated with the degree of depauperisation of the specimens and it varies considerably from axis to axis. Thus, if a " V "-shaped arrangement of the cortical cells, and hence the sporangia, is observable in a specimen otherwise referable to *G. crinale* or *G. pusillum*, there is considerable variation in the arrangement from axis to axis and a number of perfectly normal examples will be seen also. The perfect regularity seen in *G. melanoideum* is in marked contrast to this situation. The arrangement of tetrasporangia can therefore be used as a criterion for distinguishing between *G. melanoideum* and other European species of the genus, providing that it is used only with extreme caution. It is, however, clearly unjustifiable to refer to *G. melanoideum* specimens in which only a few axes show a partial or incomplete " V "-shaped arrangement of tetrasporangia.

Having established the value of the taxonomic criteria, examination of the original specimens referred by Batters to *G. melanoideum* indicates that there is no justification whatsoever for referring them other than to *G. crinale* or *G. pusillum*. In this connection it is interesting to note that at some time after Batters's death, E. M. Holmes wrote the comment " *G. crinale* form E. M. H." on the specimens from Hastings, whilst the identification " *G. pusillum* " has been written, in an unknown hand, alongside the Amory specimen from Alnmouth. It must be concluded therefore that the original specimens on which the Batters's records of *G. melanoideum* are based cannot be referred to that taxon, but are merely misidentifications. The rejection of the previously published records is not sufficient in itself to prove that *G. melanoideum* does *not* occur in the British Isles. However, from the analysis given above and the general clarification of the confusion resulting from the inadequate descriptions, it is clear that there is no justification for referring other than to *G. crinale* or *G. pusillum* those British and Irish specimens which may bear a slight resemblance in certain respects to *G. melanoideum*.

This critical survey of the evidence relating to the occurrence of *Gelidium torulosum* and *G. melanoideum* in Britain and Ireland indicates that both species must be removed from the list of indigenous species; the existing records are based entirely on misidentifications and there is no additional evidence to justify their retention.

We are indebted to the Directors of the British Museum (Natural History) and the Rijksherbarium, Leyden, Professor W. Randolph Taylor and Dr L. B. Moore for the loan of relevant herbarium material; to Dr J. Th. Koster and Mrs Y. Butler for assistance with literature and specimens. The work at Banyuls was undertaken by one of us (P.S.D.) while in receipt of a grant from the Browne Fund of the Royal Society.

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# ALGAL SPECIES LISTS

## LIST OF MARINE ALGAE COLLECTED IN THE CHANNEL ISLANDS DURING THE JOINT MEETING OF THE BRITISH PHYCOLOGICAL SOCIETY AND THE SOCIÉTÉ PHYCOLOGIQUE DE FRANCE

## SEPTEMBER 1960

During the joint meeting of the British Phycological Society and the Société Phycologique de France held in the Channel Islands in September 1960 a number of excursions were made to various localities in Guernsey, Herm and Sark. Algal records collected during these excursions are listed below. It should be realised that these lists are by no means complete in that many of the plants collected have not yet been identified. The order of species and the nomenclature are based on those of Parke (1953, 1956, 1957, 1959). Because of the difficulties involved in determining tidal zones in the field, reference is made only to the following approximate regions: supra-littoral, upper and lower mid-littoral, and sub-littoral.

The names of the Guernsey localities are taken from the Ordnance Survey map whilst for Herm and Sark the names are those in general use. The localities are numbered as follows:—

Guernsey:

1. The harbour, St. Peter Port.
2. Below Castle Cornet, St. Peter Port.
3. Pied du Mur, near Jerbourg.
4. Offshore reef, about half a mile from Fort George.
5. Jerbourg Point.
6. Petit Port, near Jerbourg.
7. Saints Bay.
8. Petit Bot.
9. Below La Prevôte watch tower.
10. Pezeries Point, Pleinmont.
11. Portelet Harbour, Pleinmont.
12. Lihou Island and causeway.
13. Long Rock, Côbo.
14. Grandes Rocques.
15. Port Soif, near Grandes Rocques.
16. Bordeaux Harbour.
17. St. Sampson.

Herm:

18. South end of the Shell Beach.
19 West coast, near the south landing.

Sark:

20. Grande Greve.
21. Near Venus Pool.

The list is a co-operative effort on the part of all the members present but, in connection with the submission of critical specimens and data, I would like to thank, particularly, for their assistance, Miss I. Adams, Miss A. Archer, Dr G. Boalch, Mrs Y. Butler, Dr E. Conway, Prof. P. Dangeard, Dr A. Davy de Virville, Mr R. Delepine, Prof. J. Feldmann, Mme P. Gayral, Dr C. den Hartog, Miss J. Hearn, Mrs D. Hepper, Dr C. van den Hoek, Dr J. Kain, Dr J. Komarek, Dr J. Th. Koster, Dr J. Lancelot, Dr M. T. Martin, Miss E. Mitchell, Dr M. W. Parke, Prof. T. Rayss, Dr A. R. A. Taylor.

The responsibility for the compilation of the lists for the four major divisions is as follows:—

| | |
|---|---|
| Chlorophyta | Dr E. M. Burrows |
| Phaeophyta | Dr H. Blackler |
| Rhodophyta | Dr P. S. Dixon |
| Myxophyta | Mr H. T. Powell |

With very few exceptions, every record is based upon a herbarium specimen. Because of the number of participants, it is not feasible to indicate, in the present list, the provenance of each record or the present whereabouts of the specimen on which it is based, but, as such information is of considerable value, the relevant data have been assembled and filed for future reference should they be required. The person responsible for the identification is cited only in those instances where no specimen was available for examination by the compilers.

PETER S. DIXON.

Hartley Botanical Laboratories,
University of Liverpool.

## Chlorophyta

*Chlorochytrium willei* Printz
1 [fide P. Dangeard]; upper mid-littoral; endophytic in *Blidingia minima*.

*Monostroma* spp. [see note 1]

*Blidingia minima* (Näg.) Kylin
1, 12, 20; upper mid-littoral.

*Enteromorpha clathrata* (Roth) Grev. [see notes 2 and 3]
2, 11, 12, 16, 21; mid-littoral.

*Enteromorpha compressa* (L.) Grev. [see note 3]
2, 11, 12, 16, 21; mid-littoral.

*Enteromorpha intestinalis* (L.) Link [see note 3]
1, 2, 6, 11, 12, 16, 18, 21; mid-littoral.

*Enteromorpha linza* (L.) J. Ag. [see note 3]
1, 6, 11, 16, 18; mid-littoral.

*Enteromorpha marginata* J. Ag. [see note 3]
8 [fide P. Gayral]; mid-littoral.

*Enteromorpha prolifera* (Müll.) J. Ag. [see note 3]
16; mid-littoral.

*Enteromorpha ramulosa* (Sm.) Hook. [see note 3]
1, 11, 12, 16, 19; mid-littoral.

*Ulva lactuca* L.
2, 6, 9, 11, 12, 14, 16, 17, 18, 21; mid-littoral and sub-littoral.

*Ulva olivacea* P. Dangeard [see note 4]
2, 18 (drift), 21 [fide P. Dangeard]; lower mid-littoral and sub-littoral.

*Ulva rigida* Ag. [*Ulva lactuca* var. *rigida* (Ag.) Le Jol.]
1, 8 [fide P. Dangeard], 18, 21 [fide C. den Hartog].

*Gayella polyrhiza* Rosenv.
1 [fide P. Dangeard, C. den Hartog]; upper mid-littoral.

*Prasiola stipitata* Suhr
1 [fide P. Dangeard]; upper mid-littoral.

*Pseudendoclonium marinum* (Rke) Aleem et Schulz
16 [fide J. Th. Koster]; lower mid-littoral.

*Gomontia polyrhiza* (Lagerh.) Born. et Flah.
16. 18; lower mid-littoral and sub-littoral.

*Chaetomorpha linum* (Müll.) Kütz.
11, 12, 13, 16; lower mid-littoral and sub-littoral.

*Chaetomorpha melagonium* (Web. et Mohr) Kütz.
20; mid-littoral.

*Cladophora falcata* Harv. [see notes 5 and 6]
2, 16; mid-littoral.

*Cladophora hutchinsiae* (Dillw.) Kütz. [see note 6]
11, 12, 14, 16, 20, 21; lower mid-littoral.

*Cladophora pellucida* (Huds.) Kütz. [see note 6]
2, 5, 12, 16; mid-littoral.

*Cladophora repens* (J. Ag.) Harv. [see note 6]
12 [fide R. Delepine]; mid-littoral.

*Cladophora rupestris* (L.) Kütz. [see note 6]
9, 11, 12, 13, 16, 17, 21; lower mid-littoral.

*Cladophora utriculosa* Kütz. [see note 6]
16 [fide Y. Butler], 18 [fide R. Delepine], 21 [fide J. Feldmann].

*Rhizoclonium implexum* (Dillw.) Kütz.
16 [fide C. den Hartog], 18 [fide J. Feldmann], mid-littoral.

*Bryopsis hypnoides* Lamour. [see note 7]
2, 8, 11, 12, 14, 16, 21; lower mid-littoral.

*Codium fragile* (Sur.) Hariot subsp. *tomentosoides* (van Goor) Silva [see note 8]
11, 15, 20; mid-littoral.

*Codium tomentosum* Stackh.
2, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 21; lower mid-littoral.

*Codium vermilara* (Olivi) Delle Chiaje.
2, 11, 12, 21; mid-littoral.

# Phaeophyta

*Acinetospora crinita* (Carm.) Kornmann
11, 12, 20; lower mid-littoral; epiphytic; plurilocular sporangia, unilocular sporangia.

*Chilionema ocellatum* (Kütz.) Kuck.
10, 12, 20; lower mid-littoral; epiphytic on *Rhodymenia palmata*.

*Ectocarpus confervoides* (Roth) Le Jol.
12, 18, 20; lower mid-littoral; epiphytic on *Laminaria digitata, L. saccharina* and *Zostera*; plurilocular sporangia.

*Ectocarpus fasciculatus* Harv.
12, 18, 20, 21; lower mid-littoral; epiphytic on *Zostera* and various algae; plurilocular sporangia, unilocular sporangia.

*Ectocarpus siliculosus* (Dillw.) Lyngb.
12, 20, 21; lower mid-littoral; epiphytic on *Laminaria saccharina*; plurilocular sporangia.

*Feldmannia simplex* (Crn) Hamel
12, 20; lower mid-littoral; endophytic in *Codium fragile*; plurilocular sporangia, unilocular sporangia.

*Giffordia hincksiae* (Harv.) Hamel
12, 20, 21; lower mid-littoral and sublittoral; epiphytic on *Laminaria digitata* and *Himanthalia elongata*; plurilocular sporangia.

*Giffordia secunda* (Kütz.) Batt.
12; lower mid-littoral; epiphytic on *Laminaria saccharina*; unilocular sporangia.

*Hecatonema maculans* (Coll.) Sauv.
21; lower mid-littoral; epiphytic on *Taonia atomaria*; plurilocular sporangia.

*Herponema valiantei* (Born.) Hamel
11, 12; lower mid-littoral; forming galls on *Cystoseira baccata*; plurilocular sporangia.

*Herponema velutinum* (Grev.) J. Ag.
5, 14, 16, 18, 20; lower mid-littoral; epiphytic on *Himanthalia elongata*; unilocular sporangia.

*Laminariocolax tomentosoides* (Farl.) Kylin
5, 21; [fide C. van den Hoek]; lower mid-littoral; epiphytic on *Saccorhiza polyschides* and *Laminaria* spp.

*Protectocarpus speciosus* (Børg.) Kuck. [*Hecatonema speciosum* (Børg.) Hamel]
21 [fide C. van den Hoek]; upper mid-littoral; epiphytic on *Cladophora pellucida*.

*Pylaiella littoralis* (L). Kjellm.
11, 12, 14, 16, 18, 20, 21; lower mid-littoral; epiphytic on Fucaceae; unilocular sporangia.

*Spongonema tomentosum* (Huds.) Kütz.
11; mid-littoral; epiphytic on *Fucus vesiculosus*; plurilocular sporangia.

*Streblonema fasciculatum* Thur.
12, 20; lower mid-littoral; endophytic in *Sauvageaugloia griffithsiana* and *Stilophora tuberculosa*; plurilocular sporangia.

*Streblonema parasiticum* (Sauv.) De Toni
20; lower mid-littoral; endophytic in *Dictyota dichotoma*; plurilocular sporangia.

*Streblonema sphaericum* (Derb. et Sol.) Thur.
11, 14, 20; lower mid-littoral; endophytic in *Mesogloia vermiculata*; plurilocular sporangia, unilocular sporangia.

*Streblonema stilophorae* (Crn) De Toni
20; lower mid-littoral; endophytic in *Sauvageaugloia griffithsiana*; plurilocular sporangia, unilocular sporangia.

*Lithoderma extensum* (Crn) Hamel
12, 18; lower mid-littoral; on stones and *Trochus* shells; plurilocular sporangia, unilocular sporangia.

*Ralfsia verrucosa* (Aresch.) J. Ag.
5, 6, 12, 16, 18, 20; lower mid-littoral; on *Patella*.

*Ascocyclus magni* Sauv.
12, 19; lower mid-littoral; on *Zostera*; plurilocular sporangia.

*Myrionema aecidioides* (K. Rosenv.) Sauv.
12, 18; lower mid-littoral; on *Saccorhiza polyschides*; plurilocular sporangia.

*Myrionema corunnae* Sauv.
5 [fide C. van den Hoek]; lower mid-littoral: epiphytic on *Laminaria* sp.

*Myrionema strangulans* Grev.
11, 12, 14, 16, 20; mid-littoral; epiphytic on various algae; plurilocular sporangia, unilocular sporangia.

*Elachista flaccida* (Dillw.) Aresch.
12, 16; lower mid-littoral; epiphytic on *Cystoseira baccata*; unilocular sporangia,

*Elachista fucicola* (Vell.) Aresch.
8, 11, 12, 13, 15, 20, 21; mid-littoral; epiphytic on Fucaceae; unilocular sporangia.

*Elachista scutulata* (Sm.) Duby
6 (drift), 12, 14, 16, 20, 21; lower mid-littoral; epiphytic on *Himanthalia elongata*; unilocular sporangia.

*Corynophlaea crispa* (Harv.) Kuck.
14, 21; lower mid-littoral; epiphytic on *Chondrus crispus*.

*Cylindrocarpus berkeleyi* (Grev.) Crn
5, 6, 7, 16, 18, 20, 21; upper mid-littoral; in cracks and crevices of rock; unilocular sporangia.

*Leathesia difformis* (L.) Aresch.
6, 10, 11, 12, 13, 14, 16, 18, 20, 21.; mid-littoral; in pools, epiphytic on various algae; plurilocular sporangia, unilocular sporangia.

*Myriactula rivulariae* (Suhr) J. Feldm. [see note 9]
10, 12; lower mid-littoral; epiphytic on *Cystoseira baccata*; plurilocular sporangia, unilocular sporangia.

*Chordaria flagelliformis* (Müll.) Ag.
13; lower mid-littoral.

*Cladosiphon zosterae* (J. Ag.) Kylin
18; lower mid-littoral; epiphytic on *Zostera*; unilocular sporangia.

*Mesogloia vermiculata* (Sm.) S. F. Gray
11, 12, 14, 16; lower mid-littoral; unilocular sporangia.

*Sauvageaugloia chordariaeformis* (Crn) Kylin [see note 10]
12; lower mid-littoral; plurilocular sporangia.

*Sauvageaugloia griffithsiana* (Grev.) Hamel.
12, 13, 20; lower mid-littoral; unilocular sporangia.

*Stilophora rhizodes* (Ehrh.) J. Ag.
11, 12, 13, 14; lower mid-littoral; plurilocular sporangia, unilocular sporangia.

*Stilophora tuberculosa* (Horn.) Rke
12; lower mid-littoral; epiphytic on *Cystoseira baccata*; unilocular sporangia.

*Myriotrichia clavaeformis* Harv.
11; lower mid-littoral; epiphytic on various algae; plurilocular sporangia.

*Myriotrichia filiformis* Harv.
11, 12; lower mid-littoral; epiphytic on various algae; plurilocular sporangia, unilocular sporangia.

*Litosiphon laminariae* (Lyngb.) Harv.
5 [fide C. van den Hoek]; lower mid-littoral; epiphytic on *Laminaria* sp.

*Litosiphon pusillus* (Carm.) Harv.
11, 12, 14, 18; lower mid-littoral; epiphytic on *Chorda filum* and *Laminaria* spp.; unilocular sporangia.

*Punctaria latifolia* Grev.
14; lower mid-littoral.

*Asperococcus fistulosus* (Huds.) Hook.
16, 21; lower mid-littoral; unilocular sporangia.

*Colpomenia peregrina* Sauv.
10, 11, 12, 14, 16, 18, 20, 21; lower mid-littoral; epiphytic on various algae, especially *Cystoseira* spp.; plurilocular sporangia.

*Scytosiphon lomentaria* (Lyngb.) Endl.
9, 10, 11, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral; plurilocular sporangia.

*Haplospora globosa* Kjellm.
11; lower mid-littoral; monosporangia, plurilocular sporangia.

*Cutleria multifida* (Sm.) Grev.
16, 21; *Aglaozonia*–stage only; lower mid-littoral.

*Carpomitra costata* (Stackh.) Batt.
16; sub-littoral.

*Desmarestia aculeata* (L.) Lamour.
11, 18, 21; lower mid-littoral and sub-littoral.

*Desmarestia dudresnayi* Lamour. [see note 11]
18 (drift); ? sub-littoral.

*Desmarestia ligulata* (Lightf.) Lamour.
6, 8, 9, 12, 13 (drift), 18, 20, 21; lower mid-littoral and sub-littoral.

*Chorda filum* (L.) Stackh.
3, 11, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral and sub-littoral; unilocular sporangia.

*Laminaria digitata* (Huds.) Lamour.
6, 10, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral and sub-littoral.

*Laminaria hyperborea* (Gunn.) Fosl.
3, 4, 8, 10, 11, 13, 14, 16, 18, 21; sub-littoral.

*Laminaria ochroleuca* La Pylaie.
3, 11, 12, 14, 16, 20, 21; lower mid-littoral and sub-littoral; unilocular sporangia.

*Laminaria saccharina* (L.) Lamour.
3, 6, 8, 10, 11, 12, 13, 14, 16, 18, 20; lower mid-littoral and sub-littoral.

*Saccorhiza polyschides* (Lightf.) Batt.
3, 6, 8, 11, 12, 18, 20, 21; lower mid-littoral and sub-littoral.

*Alaria esculenta* (L.) Grev.
12; lower mid-littoral; unilocular sporangia.

*Sphacelaria bipinnata* (Kütz.) Sauv.
6, 10, 11, 12, 14, 16, 20; lower mid-littoral; epiphytic; plurilocular sporangia, unilocular sporangia, propagules.

*Sphacelaria pennata* (Huds.) Lyngb.
var. *fusca* (Huds.) Irvine
11, 16, 20; mid-littoral; epiphytic; propagules.

var. *pennata*.
11, 12, 14, 20; lower mid-littoral; epiphytic; unilocular sporangia, propagules.

*Sphacelaria plumosa* Lyngb.
12; lower mid-littoral; epiphytic on *Halopteris scoparia*.

*Sphacelaria radicans* (Dillw.) Ag.
20; lower mid-littoral; propagules [see note 12].

*Halopteris filicina* (Grat.) Kütz.
8, 10, 11, 12, 18, 20, 21; lower mid-littoral and sub-littoral; unilocular sporangia.

*Halopteris scoparia* (L.) Sauv.
1, 6, 8, 9, 10, 11, 12, 14, 18, 20, 21; lower mid-littoral; plurilocular sporangia.

*Cladostephus spongiosus* (Huds.) Ag.
6, 9, 11, 16, 20.; lower mid-littoral.

*Cladostephus verticillatus* (Lightf.) Ag.
3, 6, 10, 11, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral and sub-littoral.

*Dictyopteris membranacea* (Stackh.) Batt.
3, 4, 10, 11, 12, 18, 21; lower mid-littoral and sub-littoral.

*Dictyota dichotoma* (Huds.) Lamour.
var. *dichotoma*.
3, 4, 6, 9, 10, 11, 12, 13, 14, 16, 18, 20, 21; mid-littoral and sub-littoral; antheridia, oogonia, tetrasporangia, occasionally all on the same thallus.
var. *intricata* (Ag.) Grev.
10, 11, 12, 13, 14, 16, 18; mid-littoral.

*Dilophus spiralis* (Mont.) Hamel
8, 12; lower mid-littoral.

*Padina pavonia* (L.) Lamour.
13, 14, 15, 18; lower mid-littoral and sub-littoral.

*Taonia atomaria* (Woodw.) J. Ag.
12, 20, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Ascophyllum nodosum* (L.) Le Jol.
6, 11, 12, 13, 14, 16, 18, 20; lower mid-littoral.
*Fucus serratus* L.
6, 8, 10, 11, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral.
*Fucus spiralis* L.
6, 10, 11, 12, 13, 14, 16, 18, 20, 21; mid-littoral.
*Fucus vesiculosus* L.
6, 8, 10, 11, 12, 13, 14, 16, 18, 20, 21; mid-littoral.
*Pelvetia canaliculata* (L.) Dcne et Thur.
6, 8, 10, 11, 12, 13, 16, 18, 20, 21; upper mid-littoral.
*Himanthalia elongata* (L.) S. F. Gray
6 (drift), 8, 9, 10, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral; fertile.

*Bifurcaria bifurcata* Ross
6, 10, 11, 12, 13, 14, 16, 17, 18, 21; lower mid-littoral; fertile.
*Cystoseira baccata* (Gmel) Silva
6, 10, 11, 12, 13, 14, 16, 17, 18, 20, 21; lower mid-littoral and sub-littoral.
*Cystoseira foeniculacea* (L.) Grev.
11, 12, 16; lower mid-littoral.
*Cystoseira granulata* Ag.
13, 14; lower mid-littoral and sub-littoral.
*Cystoseira myriophylloides* Sauv. [see note 13]
11, 12, 13, 15, 16, 17; lower mid-littoral.
*Cystoseira tamariscifolia* (Huds.) Papenf.
9, 10, 12, 13, 14, 16, 20, 21; lower mid-littoral and sub-littoral.
*Halidrys siliquosa* (L.) Lyngb.
11, 12, 13 (drift), 14, 18, 20 (drift), 21; lower mid-littoral and sub-littoral.

## Rhodophyta

*Erythrotrichia carnea* (Dillw.) J. Ag.
11; lower mid-littoral; epiphytic on *Ceramium echionotum*.
*Bangia fusco-purpurea* (Dillw.) Lyngb.
21; upper mid-littoral; monosporangia.
*Porphyra* spp. [see note 14]
*Acrochaetium bonnemaisoniae* (Batt.) J. et G. Feldm.
11; sub-littoral; endophytic in *Bonnemaisonia asparagoides*.
*Acrochaetium caespitosum* (J. Ag.) Näg.
12 [fide C. den Hartog]; mid-littoral; on *Patella*.
*Acrochaetium thuretii* (Born.) Collins et Harvey
11, 16, 21; lower mid-littoral; epiphytic on various algae; tetrasporangia.
*Audouinella membranacea* (Magn.) Papenf.
16; lower mid-littoral; on hydroid.
*Rhodochorton floridulum* (Dillw.) Näg.
6, 11, 13, 16, 20; mid-littoral; tetrasporangia.
*Helminthocladia calvadosii* (Lamour.) Setch.
9, 12, 13, 18, 20, 21; lower mid-littoral and sub-littoral; carposporophytes.
*Helminthora divaricata* (Ag.) J. Ag.
11; lower mid-littoral and sub-littoral; carposporophytes.

*Nemalion* spp. [see note 15]
5, 6, 7, 10, 12, 16, 18, 21.; mid-littoral; carposporophytes.

*Scinaia furcellata* (Turn.) Bivona
6, 12, 18; lower mid-littoral; carposporophytes.

*Scinaia turgida* Chemin
18 (drift); ? sub-littoral.

*Gelidium* spp. [see note 16]

*G. attenuatum*
5, 6, 8, 10, 16, 21; lower mid-littoral, in deep pools; tetrasporangia.

*G. crinale*
7, 10, 12, 18, 21; mid-littoral; tetrasporangia.

*G. latifolium*
8, 12, 18, 21; mid-littoral; carposporophytes, tetrasporangia.

*G. pulchellum*
5, 6, 9, 11, 12, 16, 21; lower mid-littoral; tetrasporangia.

*G. pusillum*
5, 10, 11, 12, 16, 18, 21; mid-littoral; tetrasporangia.

*Pterocladia capillacea* (Gmel.) Born. et Thur. [*Pt. pinnata* (Huds.) Papenf.]
5, 10, 12, 16, 21; lower mid-littoral, in deep pools.

*Platoma marginifera* J. Ag.
12, 20; lower mid-littoral.

*Schizymenia dubyi* (Chauv.) J. Ag.
18, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Furcellaria fastigiata* (L.) Lamour.
8, 10, 11, 12, 13, 14, 18, 20; lower mid-littoral; tetrasporangia.

*Halarachnion ligulatum* (Woodw.) Kütz.
4; sub-littoral; carposporophytes.

*Catenella repens* (Lightf.) Batt.
1, 5, 10, 11, 12, 16, 19; upper mid-littoral.

*Calliblepharis ciliata* (Huds.) Kütz.
11, 18, 21; lower mid-littoral and sub-littoral.

*Calliblepharis lanceolata* (Stackh.) Batt.
11, 13, 16, 21; lower mid-littoral; carposporophytes.

*Cystoclonium purpureum* (Huds.) Batt.
10, 11, 12, 13 (drift), 18, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Rhodophyllis divaricata* (Stackh.) Papenf.
10, 12, 16, 21; lower mid-littoral; carposporophytes.

*Plocamium coccineum* (Huds.) Lyngb.
4, 6, 10, 11, 12, 13, 14, 16, 18, 20, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Sphaerococcus coronopifolius* Stackh.
8, 14; lower mid-littoral and sub-littoral; carposporophytes.

*Gracilaria verrucosa* (Huds.) Papenf.
6, 8, 11, 14, 16, 18, 20; lower mid-littoral, in sandy pools; carposporophytes.

*Ahnfeltia plicata* (Huds.) Fries
11, 12, 16, 18, 21; lower mid-littoral.

*Gymnogongrus griffithsiae* (Turn.) Mart.
14, 19; lower mid-littoral.

*Gymnogongrus norvegicus* (Gunn.) J. Ag.
8, 18, 21; lower mid-littoral.

*Phyllophora brodiaei* (Turn.) J. Ag.
18; lower mid-littoral and sub-littoral.

*Phyllophora rubens* (L.) Grev.
3, 6, 8, 10, 11, 12, 16, 18, 21; lower mid-littoral and sub-littoral.

*Chondrus crispus* Stackh.
3, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 20, 21; lower mid-littoral and sub-littoral; carposporophytes, tetrasporangia.

*Gigartina acicularis* (Wulf.) Lamour.
6, 10, 11, 12, 14, 15, 16, 18, 20, 21; lower mid-littoral.

*Gigartina pistillata* (Gmel.) Stackh.
8, 12, 15, 18, 21; lower mid-littoral; carposporophytes, tetrasporangia.

*Gigartina stellata* (Stackh.) Batt.
5, 6, 8, 11, 12, 13, 16, 17, 20, 21; lower mid-littoral; carposporophytes.

*Dilsea carnosa* (Schmidel) Kuntze
12, 18, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Dumontia incrassata* (Müll.) Lamour.
5, 7, 8, 10, 11, 12, 16, 18, 20, 21; mid-littoral; tetrasporangia.

*Polyides rotundus* (Huds.) Grev.
7, 11, 12, 14, 16, 18; lower mid-littoral.

*Peyssonelia dubyi* Crn
18 [fide J. Feldmann]; lower mid-littoral.

*Hildenbrandia prototypus* Nardo
10 [fide J. Th. Koster]; mid-littoral.

*Corallina officinalis* L.
5, 6, 9, 10, 11, 12, 14, 16, 17, 18, 20, 21; mid-littoral; carposporophytes, tetrasporangia.

*Corallina squamata* Ellis
16, 21; lower mid-littoral.

*Jania rubens* (L.) Lamour.
5, 10, 11, 12, 14, 16; lower mid littoral and sub-littoral; tetrasporangia.

*Lithophyllum incrustans* Phil.
10, 12, 16, 19 [fide J. Th. Koster]; lower mid-littoral and sub-littoral.

*Lithophyllum orbiculatum* Fosl.
5 [fide J. Th. Koster, det. P. Lemoine]; lower mid-littoral.

*Lithothamnion lenormandii* (Aresch.) Fosl.
10, 11, 12, 16, 18 [fide J. Th. Koster]; lower mid-littoral and sub-littoral.

*Melobesia farinosa* Lamour.
12, 18; lower mid-littoral; epiphytic on *Rhodymenia* and *Zostera*.

*Melobesia minutula* Fosl.
11, 16, 20; lower mid-littoral; epiphytic on *Cladophora* spp. and *Dictyota dichotoma*.

*Mesophyllum lichenoides* (Ellis) Lemoine
6, 9, 10, 16, 21; lower mid-littoral.

*Grateloupia filicina* (Lamour.) Ag.
7, 8, 12, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Cryptonemia* sp. [see note 17]
18 (drift); ? sub-littoral.

*Halymenia latifolia* Crn
4; sub-littoral; carposporophytes.

*Callocolax neglectus* Schm.
6 (drift), 10 (drift), 18 (drift), 21; lower mid-littoral and sub-littoral; epiphytic on *Callophyllis laciniata*.

*Callophyllis laciniata* (Huds.) Kütz.
6 (drift), 8, 10 (drift), 12, 16, 18 (drift), 21; lower mid-littoral and sub-littoral; carposporophytes.

*Kallymenia reniformis* (Turn.) J. Ag.
18, 21; lower mid-littoral and sub-littoral.

*Meredithia microphylla* J. Ag.
12 [fide C. den Hartog]; lower mid-littoral.

*Naccaria wiggii* (Turn.) Endl.
11; sub-littoral; carposporophytes.

*Asparagopsis armata* Harv.
3, 6, 8, 10, 11, 12, 13, 14, 16, 18, 19, 20, 21; lower mid-littoral and sub-littoral.

*Falkenbergia rufolanosa* (Harv.) Schm.
4, 8, 11, 12, 14, 16, 19, 20, 21; lower mid-littoral and sub-littoral.

*Bonnemaisonia asparagoides* (Woodw.) Ag.
11, 12 (drift); sub-littoral; carposporophytes.

*Champia parvula* (Ag.) Harv.
6, 9, 14, 16, 18, 21; lower mid-littoral.

*Chylocladia reflexa* Lenorm.
16; lower mid-littoral.

*Chylocladia verticillata* (Lightf.) Bliding
9, 11, 13, 16, 18, 21.; lower mid-littoral and sub-littoral; frequently epiphytic on other algae.

*Gastroclonium ovatum* (Huds.) Papenf.
6, 9, 10, 11, 12, 14, 16, 18, 20, 21; lower mid-littoral, in pools; carposporophytes, tetrasporangia.

*Lomentaria articulata* (Huds.) Lyngb.
6, 8, 9, 10, 11, 12, 16, 18, 21; lower mid-littoral; tetrasporangia.

*Lomentaria clavellosa* (Turn.) Gaill.
16, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Rhodymenia palmata* (L.) Grev.
6, 8, 10, 11, 12, 13, 14, 16, 17, 18, 20, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Rhodymenia pseudopalmata* (Lamour.) Silva
9, 18 (drift); lower mid-littoral (? and sub-littoral).

*Aglaothamnion roseum* (Roth) J. Feldm. [*Callithamnion roseum* (Roth) Harv.]
18 [fide J. Feldmann]; lower mid-littoral.

*Antithamnion cruciatum* (Ag.) Näg.
11; lower mid-littoral; epiphytic on *Ceramium* spp.; tetrasporangia.

*Antithamnion sarniense* (Lyle) G. Feldm.
3, 4, 6, 7, 8 (drift), 11, 16, 17, 18, 19, 21; lower mid-littoral and sub-littoral; epiphytic on various algae and *Zostera*; tetrasporangia.

*Bornetia secundiflora* (J. Ag.) Thur.
6, 8, 10, 11, 12, 16, 18; lower mid-littoral.

*Callithamnion granulatum* (Ducluz.) Ag.
11; lower mid-littoral; tetrasporangia.

*Callithamnion hookeri* (Dillw.) Ag.
18; lower mid-littoral; tetrasporangia.

*Callithamnion tetragonum* (Wither.) Ag.
12, 14, 16, 21; lower mid-littoral; epiphytic on various algae; tetrasporangia.

*Callithamnion tetricum* (Dillw.) Ag.
6, 11, 14, 16; lower mid-littoral; tetrasporangia.

*Ceramium ciliatum* (Ellis) Ducluz.
5, 7, 8, 9, 10, 11, 12, 16, 18, 21; mid-littoral; carposporophytes, tetrasporangia.

*Ceramium echionotum* J. Ag.
5, 7, 10, 11, 12, 16, 18, 20, 21; lower mid-littoral; tetrasporangia.

*Ceramium flabelligerum* J. Ag.
11, 16; lower mid-littoral; tetrasporangia.

*Ceramium rubrum* (Huds.) Ag. [see note 18]
5, 9, 10, 11, 12, 16, 18, 20, 21; mid-littoral; carposporophytes, tetrasporangia.

*Ceramium shuttleworthianum* (Kütz.) Silva [*C. acanothonotum* (Carm. ex Harv.) J. Ag.]
2, 5, 6, 7, 10, 12, 16, 21; mid-littoral; carposporophytes, tetrasporangia.

*Corynospora pedicellata* (Sm.) J. Ag.
8, 12, 16; lower mid-littoral; monosporangia.

*Crouania attenuata* (Ag.) J. Ag.
8, 11, 16, 18, 21; lower mid-littoral; epiphytic on *Ceramium* spp. and various coralline algae; tetrasporangia.

*Griffithsia corallinoides* (L.) Batt.
6, 9, 11, 12, 16, 18, 21; lower mid-littoral; tetrasporangia.

*Griffithsia flosculosa* (Ellis) Batt.
6, 8, 9, 10, 11, 12, 13, 14, 16, 18, 21; lower mid-littoral; tetrasporangia.

*Halurus equisetifolius* (Lightf.) Batt.
var. *equisetifolius*.
6, 8 (drift), 10, 11, 12, 14, 16, 18, 20, 21; lower mid-littoral and sub-littoral; tetrasporangia.
var. *simplicifilum* J. Ag.
11, 12; lower mid-littoral.

*Pleonosporium borreri* (Sm.) Näg. ex Hauck
11, 16, 21; lower mid-littoral.

*Plumaria elegans* (Bonnem.) Schm. [see note 19]
6, 8, 10, 11, 12, 16, 18, 20, 21; lower mid-littoral; carposporophytes, parasporangia, tetrasporangia.

*Spermothamnion repens* (Dillw.) K. Rosenv.
5, 11, 12, 16; lower mid-littoral; tetrasporangia.

*Sphondylothamnion multifidum* (Huds.) Näg.
6, 9, 11, 12, 13, 14, 18, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Acrosorium uncinatum* (Turn.) Kylin
9, 12, 18, 19, 21; lower mid-littoral and sub-littoral; frequently epiphytic on other algae.

*Apoglossum ruscifolium* (Turn.) J. Ag.
6, 10, 11, 14, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Cryptopleura ramosa* (Huds.) Kylin.
4, 6, 8 (drift), 9, 10, 11, 12, 16, 18, 19, 21; lower mid-littoral and sub-littoral; carposporophytes, tetrasporangia.

*Delesseria sanguinea* (Huds.) Lamour.
7, 8, 10, 11, 12, 16, 18, 21; lower mid-littoral and sub-littoral.

*Drachiella spectabilis* Ernst et Feldm.
21; sub-littoral; tetrasporangia.

*Hypoglossum woodwardii* Kütz.
6, 7, 8, 11, 12, 16, 18, 21; lower mid-littoral; tetrasporangia.

*Membranoptera alata* (Huds.) Stackh.
6, 11, 12, 16, 18, 21; lower mid-littoral; carposporophytes.

*Nitophyllum punctatum* (Stackh.) Grev.
6, 8, 21; lower mid-littoral; tetrasporangia.

*Phycodrys rubens* (Huds.) Batt.
8, 11, 12, 16 (drift), 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Polyneura gmelinii* (Grev.) Kylin
18 (drift) [fide J. Lancelot]; ? sub-littoral.

*Polyneura hilliae* (Grev.) Kylin
11, 12, 18 (drift), 20, 21; lower mid-littoral and sub-littoral; carposporophytes, tetrasporangia.

*Dasya arbuscula* [see note 20]
6, 8, 10, 11, 12, 16, 18, 21; lower mid-littoral; tetrasporangia.

*Heterosiphonia plumosa* (Ellis) Batt.
4, 6, 8, 11, 12, 14, 16, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Brongniartella byssoides* (Good. et Woodw.) Schm.
6, 11, 13, 14, 21; lower mid-littoral and sub-littoral; carposporophytes, spermatangia, tetrasporangia.

*Chondria caerulescens* J. Ag.
8; mid-littoral, in shallow pool.

*Chondria dasyphylla* (Woodw.) Ag.
8, 11, 12, 14, 16, 18; lower mid-littoral.

*Chondria tenuissima* (Good. et Woodw.) Ag.
11 (drift), 12; lower mid-littoral (? and sub-littoral).

*Halopitys incurvus* (Huds.) Batt.
11, 12; lower mid-littoral, in shallow sandy pools.

*Laurencia hybrida* (D.C.) Lenorm. ex Duby
11, 16, 21; lower mid-littoral.

*Laurencia obtusa* (Huds.) Lamour.
7, 8, 10, 11, 12, 14, 16, 18, 21; lower mid-littoral.

*Laurencia pinnatifida* (Huds.) Lamour.
2, 6, 7, 8, 9, 10, 11, 12, 14, 16, 18, 21; mid-littoral.

*Polysiphonia brodiaei* (Dillw.) Grev.
11, 12, 16, 20; lower mid-littoral; carposporophytes, tetrasporangia.

*Polysiphonia elongata* (Huds.) Harv.
11, 12, 21; lower mid-littoral and sub-littoral; tetrasporangia.

*Polysiphonia fruticulosa* (Wulf.) Spreng.
11, 12, 13, 14, 16; mid-littoral; carposporophytes, tetrasporangia.

*Polysiphonia lanosa* (L.) Tandy
11, 16, 18, 20; mid-littoral; epiphytic on *Ascophyllum nodosum*.

*Polysiphonia macrocarpa* Harv.
12, 21 [fide J. Feldman]; lower mid-littoral.

*Polysiphonia nigrescens* (Sm.) Grev.
11, 12, 16, 18, 21; mid-littoral; tetrasporangia.

*Polysiphonia urceolata* (Dillw.) Grev.
12; lower mid-littoral; carposporophytes.

*Polysiphonia violacea* (Roth) Grev.
11, 12, 16, 18, 21; lower mid-littoral; carposporophytes, tetrasporangia.

*Pterosiphonia thuyoides* (Harv.) Schm.
11, 18; lower mid-littoral.

*Rhodomela confervoides* (Huds.) Silva
10, 11, 12, 13, 16, 18, 20; lower mid-littoral; carposporophytes, tetrasporangia.

## Myxophyta

*Microcystis litoralis* (Hansg. in Fosl.) Forti
[ = *Coccochloris stagnina* Spreng., in Drouet & Daily (1956, p. 17) ]
1, 11, 12, 16; mid-littoral; in pools, or moist places.

*Chroococcus turgidus* (Kütz.) Näg.
[ = *Anacystis dimidiata* (Kütz.) Dr. et Daily, in Drouet & Daily (1956, p. 70) ]
11, 12; mid-littoral; in pools, or moist places.

*Merismopedia glauca* f. *mediterranea* (Näg.) Collins
[ = *Agmenellum thermale* (Kütz.) Dr. et Daily, in Drouet & Daily (1956, p. 90) ]
6, 11, 12, 16; mid-littoral; in pools, or moist places and on sand.

*Entophysalis granulosa* Kütz.
[ = *Entophysalis deusta* (Menegh.) Dr. et Daily, in Drouet & Daily (1956, p. 103) ]
19, 21; upper mid-littoral.

*Xenococcus acervatus* Setch. et Gardn.
[ = *Entophysalis conferta* (Kütz.) Dr. et Daily, in Drouet & Daily (1956, p. 112) ]
1, 11, 12, 16, 21; mid-littoral; in pools, epiphytic.

*Xenococcus schousboei* Thur. in Born. et Thur.
[ = *Entophysalis conferta* (Kütz.) Dr. et Daily, in Drouet & Daily (1956, p. 111) ]
12, 21; mid-littoral; epiphytic.

*Anabaena torulosa* (Carm.) Lagerh. ex Born. et Flah.
11, 12; mid-littoral; in pools, epiphytic.

*Calothrix aeruginosa* (Kütz.) Thur. ex Born. et Flah.
1, 11, 12; mid-littoral; in pools, epiphytic.

*Calothrix confervicola* (Roth) Ag. ex Born. et Flah.
1, 11, 12; mid-littoral; in pools, epiphytic.

*Calothrix scopulorum* (Web. et Mohr) Ag. ex Born. et Flah.
12, 21; supra-littoral.

*Rivularia atra* Roth ex Born. et Flah.
1, 5, 11, 12, 18; upper mid-littoral; in pools, locally very common.

*Rivularia bullata* (Poir.) Berk. ex Born. et Flah.
6, 11, 12, 13, 16; upper mid-littoral; on rock and on *Lichina pygmaea*.

*Fremyella grisea* (Thur. ex Born. et Flah.) J. De Toni
1, 11, 12, 16; mid-littoral; in pools, epiphytic.

*Plectonema golenkinianum* Gom.
1, 6, 11, 12, 18, 21; mid-littoral; in pools and other moist places.

*Lyngbya aestuarii* (Mertens) Liebm. ex Gom.
1, 16, 21; mid-littoral; in pools, epiphytic.

*Lyngbya infixa* Fremy
11, 12; mid-littoral; in pools, epiphytic.

*Lyngbya majuscula* Harv. ex Gom.
21; mid-littoral; in pools, epiphytic.

*Lyngbya semiplena* J. Ag. ex Gom.
11, 12, 21; mid-littoral; in pools, epiphytic.

*Oscillatoria margaritifera* Kütz. ex Gom.
1, 12, 16; mid-littoral; in pools, epiphytic.

*Phormidium fragile* Gom.
16; mid-littoral; in pools, epiphytic.

*Phormidium minutum* Lindstedt
1, 11, 12; mid-littoral; in pools, epiphytic, locally abundant.

*Phormidium subsalsum* Gom.
6, 12, 21; mid-littoral; in moist places.

*Schizothrix cresswellii* Harv. ex Gom.
1; mid-littoral; in moist places.

*Spirulina subsalsa* Oerst. ex Gom.
1, 11, 12, 16, 21; mid-littoral; in pools and moist places.

*Symploca hydnoides* Kütz. ex Gom.
11, 12, 21; mid-littoral; in pools and moist places.

## NOTES

1. Numerous specimens of *Monostroma* were collected, but because of the uncertain status of the species of this genus no attempt could be made to name these.
2. *sensu* Harvey (1851, plate 340).
3. Numerous specimens of *Enteromorpha* were collected which, at the present time, cannot be referred satisfactorily to the described species.
4. Hitherto unrecorded for the British Isles.
5. *sensu* Harvey (1849, plate 216).
6. Numerous specimens of *Cladophora* were collected, but, because of the uncertain status of many of the species of this genus and the bewildering range of form exhibited in the collected material, identification of these is impossible at the present time.
7. Many specimens, which cannot be referred satisfactorily to either *Bryopsis hypnoides* or *B. plumosa*, were also collected. During the meeting many specimens were identified as *B. plumosa*, but on subsequent examination none of the specimens available agreed with this taxon as it occurs in other parts of the British Isles.
8. Specimens intermediate between subsp. *atlanticum* and subsp. *tomentosoides* were also reported. Although numerous specimens were identified during the meeting as subsp. *atlanticum*, none of those examined subsequently was referable to that taxon.
9. A further collection, from 11, epiphytic on *Cystoseira myriophylloides*, cannot be referred to any known species of the genus.
10. First record for the British Isles. Figured by Hamel (1935) as *Castagnea chordariaeformis* (Crn) Thuret in Flahault.
11. Particularly interesting in view of its very rare, but widespread, occurrence in the British Isles during the last 100 years. Further reference to this record is made on p. 87.
12. Propagules hitherto unrecorded for this species.
13. First record for the British Isles.
14. Numerous specimens were collected although, because of the uncertain status of the described entities, identification is impracticable at the present time.
15. The specimens collected showed considerable variation in the degree of branching and all intermediate states occurred between *N. elminthoides* (Vell.) Batt. and *N. multifidum* (Web. et Mohr) J. Ag.
16. Taxonomy and nomenclature in the genus *Gelidium* are so confused that precise citation is impossible; the epithets used are cited *sensu* Feldmann and Hamel (1936).

17. First record of a species of *Cryptonemia* for the British Isles. It has been suggested (den Hartog, private communication) that these specimens should be referred to either *C. lactuca* or *C. seminervis*. Specific delimination in the genus *Cryptonemia* is notoriously difficult and for this reason it is thought better not to give a precise identification until more detailed studies of the relevant materials can be made.
18. A considerable number of specimens was collected for which precise attribution cannot be made at present ; the sub-littoral material in particular has proved to be extremely difficult. Identification of these specimens must await monographic treatment of the *diaphanum/strictum* and *rubrum/pedicellatum* complexes.
19. In Guernsey it was observed that small specimens of this species growing in pools under conditions of moderate exposure tended to have increased development of cortical tissue so that the plants stand erect ; such plants bear a strong resemblance to *Ptilota plumosa*. The distribution of the latter is more northerly than that of *Plumaria elegans* and it is likely that the reports of its occurrence in southern England result from misidentifications of this form of *Plumaria*, which appears to have been ignored previously.
20. Numerous specimens of *Dasya* were collected, but untill the present nomenclatural chaos in that genus is resolved identification is impossible. The majority of collected specimens is referable to *D. arbuscula sensu* Harvey (1849, plate 224), although it should be realised that the type of *Conferva arbuscula* is not of that genus so that the name is being used incorrectly. A number of specimens not referable to *D. arbuscula* were also collected and it is hoped to present more detailed analyses of these in the near future.

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## SOME SUB-LITTORAL RECORDS

### (a) Alderney

During the week preceding the British Phycological Society meeting in the Channel Islands in 1960, a single dive was made with an aqualung from the end of the breakwater of Braye Harbour, Alderney, and a series of algal samples collected.

The plants were removed with the aid of a scraper (Kain 1960) with a net bag attached, using a different bag for each depth sampled. Qualitative samples were taken by this method from just below Chart Datum to the lowest limit of the rock at 18 metres. The depth was measured with a capillary tube depth gauge ; the height of the tide, calculated from the Admiralty Tide Tables, was subtracted to obtain the depth below Chart Datum.

The sampling line ran southwestwards from the present end of Braye breakwater at right angles to the general line of the breakwater itself. It was thus on the sheltered side. Below the vertical stone wall there was a steeply sloping (about one in one) boulder bed extending from about the level of Chart Datum to the muddy sand at 18 metres below Chart Datum.

The species found at the different depths are shown in Table 1. The vegetation was dominated by a mixture of *Laminaria hyperborea* and *L. ochroleuca*, both of which extended for the whole depth range though the forest thinned considerably at lower depths. The plants of *L. ochroleuca* were markedly larger than those of *L. hyperborea*.

# TABLE 1

The species occurring in samples from different depths at Alderney

+ = present; T = tetrasporangia; C = cystocarps; B = both tetrasporangia and cystocarps

| Depth (metres below Chart Datum): | 1·4 | 2·3 | 4·4 | 6·2 | 7·8 | 9·3 | 11·5 | 13·2 | 15·4 | 17·9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Chlorophyceae | | | | | | | | | | |
| *Ulva lactuca* L. | + | — | — | — | — | — | — | — | — | — |
| Phaeophyceae | | | | | | | | | | |
| *Alaria esculenta* (L.) Grev. | + | + | — | — | — | — | — | — | — | — |
| *Carpomitra costata* (Stackh.) Batt. | — | — | — | — | — | — | + | + | + | + |
| *Cladostephus verticillatus* (Lightf.) Ag. | — | — | — | + | — | — | — | — | — | — |
| *Cutleria multifida* (Sm.) Grev. (sporophyte) | — | — | — | + | — | — | — | + | — | — |
| *Desmarestia aculeata* (L.) Lamour. | — | — | + | + | — | + | + | — | — | — |
| *Dictyopteris membranacea* (Stackh.) Batt. | — | — | — | — | + | — | + | + | + | + |
| *Dictyota dichotoma* (Huds.) Lamour. | + | + | + | + | + | + | + | + | + | + |
| *Giffordia hincksiae* (Harv.) Hamel | + | — | — | — | — | — | — | — | — | — |
| *Halopteris filicina* (Grat.) Kütz. | — | — | — | + | + | + | + | + | + | + |
| *Laminaria hyperborea* (Gunn.) Fosl. | + | + | + | + | + | + | + | + | + | + |
| *L. ochroleuca* La Pylaie | + | + | + | + | — | — | + | + | + | + |
| *L. saccharina* (L.) Lamour. | + | + | + | + | + | + | + | — | — | — |
| *Saccorhiza polyschides* (Lightf.) Batt. | + | + | + | + | — | — | — | — | — | — |
| Rhodophyceae | | | | | | | | | | |
| *Antithamnion sarniense* (Lyle) G. Feldm. | + | — | — | — | — | — | + | + | + | + |
| *Apoglossum ruscifolium* (Turn.) J. Ag. | — | — | — | — | — | — | + | — | — | — |
| *Asparagopsis armata* Harv. (tetrasporic phase). | — | — | — | — | — | — | — | + | T | + |
| *Bonnemaisonia asparagoides* (Woodw.) Ag. | — | — | — | — | — | — | — | C | C | C |
| *Brongniartella byssoides* (Good. et Woodw.) Schm. | — | — | — | — | — | — | — | — | + | — |
| *Calliblepharis ciliata* (Huds.) Kütz. | — | — | — | — | — | + | — | + | + | + |
| *Callophyllis laciniata* (Huds.) Kütz. | + | + | + | + | + | — | + | + | — | — |
| *Chondrus crispus* (L.) Stackh. | + | + | — | — | — | — | — | — | — | — |
| *Corallina officinalis* L. | + | + | + | + | + | + | — | — | — | — |
| *Cryptopleura ramosa* (Huds.) Kylin | C | — | — | — | B | — | + | + | + | + |
| *Delesseria sanguinea* (Huds.) Lamour. | + | + | — | — | — | — | — | — | — | — |
| *Dilsea carnosa* (Schmidel) Kuntze | — | — | — | — | + | — | — | — | — | — |
| *Griffithsia corallinoides* (L.) Batt. | — | — | — | — | — | — | + | — | + | B |
| *G. flosculosa* (Ellis) Batt. | — | — | — | — | — | + | — | + | + | + |
| *Heterosiphonia plumosa* (Ellis) Batt. | — | — | — | + | + | + | — | + | — | + |
| *Lomentaria articulata* (Huds.) Lyngb. | + | — | — | — | — | — | — | + | — | — |
| *Peyssonelia atropurpurea* Crn | — | + | — | + | + | + | — | + | — | — |
| *Phyllophora membranifolia* (Good. et Woodw.) J. Ag. | — | — | — | — | + | — | — | — | + | — |
| *P. rubens* (L.) Grev. | — | — | — | — | + | + | — | + | + | + |
| *Plocamium coccineum* (Huds.) Lyngb. | C | — | — | — | + | + | + | + | + | T |
| *Polyneura* sp. | — | T | — | B | — | — | B | + | + | — |
| *Rhodymenia palmata* (L.) Grev. | + | — | — | — | — | — | — | — | — | — |
| *Scinaia furcellata* (Turn.) Bivona | — | — | — | — | — | — | + | — | — | — |
| *Spermothamnion* sp. | — | — | — | — | — | — | — | — | + | — |

## TABLE 2

The species occurring in the samples from different depths in the Firth of Clyde.

+ = present; T = tetrasporangia; C = cystocarps; B = both tetrasporangia and cystocarps; S = spermatangia; P = plurilocular sporangia.

| | Keppel Point | | | Farland Point | | | | | East Little Cumbrae | | | | | Rùnnan-eùn Point | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m. below Chart Datum): | 1·7 | 3·0 | 4·5 | 2·5 | 3·7 | 5·2 | 6·8 | 7·4 | 3·4 | 7·1 | 9·5 | 12·9 | 16·0 | 2·6 | 4·0 | 5·3 | 6·5 | 7·4 | 7·7 |
| Chlorophyceae | | | | | | | | | | | | | | | | | | | |
| *Monostroma* sp. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | + | — | — |
| *Ulva lactuca* L. | — | — | — | — | — | — | — | + | — | — | — | — | — | — | — | — | — | — | — |
| Phaeophyceae | | | | | | | | | | | | | | | | | | | |
| *Cutleria multifida* (Sm.) Grev. (gametophyte) | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | + | — | — |
| *C. multifida* (sporophyte) | + | — | — | + | + | + | + | — | + | + | — | — | — | — | — | — | — | — | — |
| *Desmarestia aculeata* (L.) Lamour. | — | — | — | — | + | — | — | — | + | + | — | — | — | — | — | — | — | — | — |
| *D. ligulata* (Lightf.) Lamour. | — | — | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Ectocarpus confervoides* (Roth) Le Jol. s. lat. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | — | + | — |
| *Giffordia fuscata* (Zan.) Kuck. | | | | | | | | | | | | | | | | | | | |
| var. *arachnoidea* (Rke.) Kylin | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | — |
| *G. granulosa* (Sm.) Hamel | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | — | — |
| *G. sandriana* (Zanard.) Hamel | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | P |
| *G. secunda* (Kütz.) Batt. | — | — | — | — | P | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Laminaria digitata* (Huds.) Lamour. | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *L. hyperborea* (Gunn.) Fosl. | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *L. saccharina* (L.) Lamour | + | + | + | + | + | + | + | — | + | + | + | — | — | + | + | + | — | — | — |
| *Leptonema fasciculatum* Rke. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | P |
| *Saccorhiza polyschides* (Lightf.) Batt. | + | — | — | + | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Sphacelaria pennata* (Huds.) Lyngb. | — | — | — | — | — | — | — | — | + | — | — | — | — | — | — | — | — | — | — |
| *Stictyosiphon tortilis* (Rupr.) Rke. | — | — | + | + | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

# TABLE 2 (*Cont.*)

| Depth (m. below Chart Datum): | 1·7 | 3·0 | 4·5 | 2·5 | 3·7 | 5·2 | 6·8 | 7·4 | 3·4 | 7·1 | 9·5 | 12·9 | 16·0 | 2·6 | 4·0 | 5·3 | 6·5 | 7·4 | 7·7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rhodophyceae | | | | | | | | | | | | | | | | | | | |
| *Antithamnion plumula* (Ellis) Thur. | — | — | — | — | — | — | — | + | — | — | + | + | — | — | — | — | — | — | — |
| *A. sarniense* (Lyle) G. Feldm. | — | — | — | — | — | + | — | — | — | — | — | — | — | — | + | — | + | + | — |
| *Bonnemaisonia asparagoides* (Woodw.) Ag. | — | — | — | — | — | — | — | — | — | S | + | — | — | — | — | — | — | — | — |
| *B. hamifera* Hariot (tetrasporophyte) | — | — | — | — | — | — | — | — | — | + | + | + | — | — | — | — | — | + | — |
| *Brongniartella byssoides* (Good. et Woodw.) Schm. | — | — | — | — | — | — | — | — | — | + | + | — | — | — | — | — | — | — | — |
| *Callithamnion corymbosum* (Sm.) Lyngb? | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | — | — |
| *Callithamnion* sp. | — | — | — | — | — | — | — | — | — | — | — | + | — | — | — | + | T | + | — |
| *Compsothamnion* sp. | — | — | — | — | — | — | — | — | — | + | + | — | — | — | — | — | — | — | — |
| *Cruoria pellita* (Lyngb.) Fries | — | — | — | — | — | — | — | — | — | — | — | — | — | + | + | + | — | — | — |
| *Cruoria*? | — | — | — | — | — | — | — | — | — | — | — | — | + | — | — | — | — | — | — |
| *Cryptopleura ramosa* (Huds.) Kylin | T | T | — | T | + | + | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Delesseria sanguinea* (Huds.) Lamour. | + | + | + | + | + | + | + | — | + | + | + | + | — | — | — | — | — | — | — |
| *Dilsea carnosa* (Schmidel) Kuntze | — | — | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Gigartina stellata* (Stackh.) Batt. | — | — | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Halarachnion ligulatum* (Woodw.) Kütz. | — | — | — | — | — | — | — | — | — | — | + | + | — | — | — | — | — | — | — |
| *Lomentaria clavellosa* (Turn.) Gaill. | — | — | — | — | — | — | — | — | — | — | B | + | — | — | — | — | — | — | — |
| *L. orcadensis* (Harv.) Collins | — | — | — | — | — | — | — | — | — | — | T | — | — | — | — | — | — | — | — |
| *Nitophyllum* agg. | — | — | — | — | — | — | — | — | — | — | C | — | — | — | — | — | — | — | — |
| *Odonthalia dentata* (L.) Lyngb. | + | + | — | + | + | — | — | — | + | + | — | — | — | — | — | — | + | — | — |
| *Phycodrys rubens* (Huds.) Batt. | + | + | — | + | + | T | + | — | — | + | + | + | — | — | — | — | — | — | — |
| *Polysiphonia elongata* (Huds.) Harv. | — | — | — | + | — | — | — | + | — | — | — | — | — | — | — | — | — | — | — |
| *P. nigrescens* (Sm.) Grev. | — | — | — | — | — | — | — | B | — | — | — | — | — | — | — | — | — | — | — |
| *P. urceolata* agg. | — | — | + | — | — | — | — | — | — | + | + | — | — | T | — | + | + | — | + |
| *Porphyra umbilicalis* (L.) Kütz. | — | — | + | — | — | — | — | + | — | — | — | — | — | — | — | + | — | — | — |
| *Rhodomela confervoides* (Huds.) Silva | — | — | + | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| *Rhodophyllis divaricata* (Stackh.) Papenf. | — | — | — | — | — | — | — | — | — | — | — | + | — | — | — | — | — | — | — |
| *Rhodymenia palmata* (L.) Grev. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | + | — | — | — |

## TABLE 3

The species occurring in the samples from different depths in Gairloch and Loch Torridon.

+ = present ; T = tetrasporangia ; C = cystocarps ; B = both tetrasporangia and cystocarps ; S = spermatangia ;
U = unilocular sporangia ; b = both oogonia and antheridia.

| | Glas Eilean | | | Longa Island | | | Loch Torridon | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Inner | Outer | | S | | SW | Sgneir na Trian | | | |
| Depth (m. below Chart Datum): | 4·9 | 12·0 | 13·5 | 8.0 | 13·1 | 7·5 | 15·5 | 17·6 | 20·1 | 23·4 |
| Chlorophyceae | | | | | | | | | | |
| *Cladophora* sp. | + | — | + | — | — | — | — | — | — | — |
| *Enteromorpha clathrata* (Roth) Grev. | — | + | — | — | — | — | — | — | — | — |
| *Monostroma* sp. | + | — | — | — | — | — | — | — | — | — |
| Phaeophyceae | | | | | | | | | | |
| *Acrothrix* sp. | + | — | — | — | — | — | — | — | — | — |
| *Asperococcus fistulosus* (Huds.) Hook. | U | + | U | — | — | — | — | — | — | — |
| *Chorda tomentosa* Lyngb. | U | — | — | — | — | — | — | — | — | — |
| *Cutleria multifida* (Sm.) Grev. (gametophyte) | b | + | — | — | — | — | — | — | — | — |
| *C. multifida* (sporophyte) | + | — | — | + | — | + | + | + | + | + |
| *Dictyota dichotoma* (Huds.) Lamour. | — | — | + | + | — | + | + | + | — | + |
| *Giffordia hincksiae* (Harv.) Hamel | — | + | — | — | — | — | + | — | — | — |
| *Laminaria hyperborea* (Gunn.) Fosl. | + | + | — | + | — | + | + | + | — | — |
| *L. saccharina* (L.) Lamour. | + | — | + | — | + | — | + | + | — | — |
| *Stictyosiphon tortilis* (Rupr.) Rke. | — | — | — | — | — | + | + | — | — | — |
| Rhodophyceae | | | | | | | | | | |
| *Antithamnion sarniense* (Lyle) G. Feldm. | — | — | — | — | — | — | + | — | — | — |
| *Bonnemaisonia asparagoides* (Woodw.) Ag. | — | — | C | C | — | + | C | C | C | C |
| *B. hamifera* Hariot sporophyte | + | + | — | + | + | — | + | + | + | — |
| *Brongniartella byssoides* (Good. et Woodw.) Schm. | — | — | — | + | — | + | S | — | — | — |

## TABLE 3 (*Cont.*)

| Depth (m. below Chart Datum): | 4·9 | 12·0 | 13·5 | 8·0 | 13·1 | 7·5 | 15·5 | 17·6 | 20·1 | 23·4 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Callophyllis laciniata* (Huds.) Kütz. | — | — | — | — | — | + | + | — | — | + |
| *Compsothamnion* sp. | — | — | — | — | — | — | — | — | + | — |
| *Cryptopleura ramosa* (Huds.) Kylin | — | — | — | T | — | T | — | — | — | — |
| *Delesseria sanguinea* (Huds.) Lamour. | — | — | — | — | + | + | — | — | — | — |
| *Heterosiphonia plumosa* (Ellis) Batt. | — | — | — | — | + | — | — | — | — | — |
| *Kallymenia reniformis* (Turn.) J. Ag. | — | — | — | + | — | — | — | — | — | — |
| *Lomentaria clavellosa* (Turn.) Gaill. | — | — | — | — | T | — | T | T | — | — |
| *Nitophyllum* sp. | — | — | — | B | — | C | C | — | — | — |
| *Odonthalia dentata* (L.) Lyngb. | — | — | — | — | + | + | — | — | — | — |
| *Phycodrys rubens* (Huds.) Batt. | — | — | — | + | + | + | + | + | + | + |
| *Plocamium coccineum* (Huds.) Lyngb. | — | — | + | + | — | + | + | + | + | — |
| *Polysiphonia elongata* (Huds.) Harv. | — | — | + | — | — | — | — | — | — | — |
| *P. urceolata* agg. | — | — | — | — | — | — | + | — | + | — |
| *Pterosiphonia parasitica* (Huds.) Fkbg. | — | — | — | T | — | + | T | — | — | — |
| *Rhodophyllis divaricata* (Stackh.) Papenf. | — | + | — | — | — | — | + | — | — | — |
| *Scinaia furcellata* (Turn.) Bivona | — | — | + | — | — | — | — | — | — | — |

### (b) West of Scotland

In June 1960, again using an aqualung, sub-littoral algal samples were collected from two regions in Scotland. In the Firth of Clyde two sites were sampled on the island of the Greater Cumbrae, to the south of Keppel Pier where rock sloped steeply to sand with occasional boulders at 4.5 metres, and off Farland Point where the rocks sloped very gently down to gravel and boulders at 7 metres. A third site was taken on the eastern side of the northern arm of Little Cumbrae, where steeply sloping rock was mixed with large boulders down to gravel at 18.4 metres; and a fourth site was chosen to the north of Rùnnan-eùn Point on the island of Bute, where boulders and rock sloped very steeply to gravel at 9.6 metres. None of these shores is subjected to severe wave action of the depth-penetrating (long wave-length) type, and sub-littorally all are to be regarded as sheltered positions. The transmission of light through the Clyde waters was low, and this may account for the fact that only one algal form was found at 16 metres, the lowest station sampled. The species recorded are shown in Table 2.

In Ross-shire, dives were made off islands in Gairloch and Loch Torridon. At the small island of Glas Eilean near the head of Gairloch, samples were taken from the inner sheltered and the outer exposed sides, both of which shores sloped steeply, though the outer exposed site levelled to boulders and sand at 12 metres. At Longa Island at the mouth of the Gairloch, both the sites sampled were exposed to considerable wave action; and, at the mouth of Loch Torridon, a series of deeper samples was obtained from the steeply sloping boulders associated with the isolated rocky reef, Sgneir na Trian. The records are shown in Table 3. The forest of *Laminaria hyperborea* found off Longa Island was particularly noteworthy, with its undergrowth of mainly Rhodophycean forms; on the island of Glas Eilean, where the dominant form was *L. saccharina*, the number of Rhodophycean species decreased and the number of Phaeophycean forms was markedly increased. The light transmission through the water of this northern region was very high, and the presence of 5 species at 23 metres is noteworthy.

I am very grateful to those who made these dives possible: to my parents (Mr and Mrs A C. Kain) and Dr D. Jolly at Alderney, to Miss W. B. Chapman who accompanied me to Scotland and handled the safety line, the Director of the Marine Station, Millport, the master of *Mizpah*, the owner of *Ma Run* and to Mr Cecil Powrie of Salmon Fisheries, Gairloch. Very many thanks are due to Dr H. Blackler, Dr E. M. Burrows and Dr P. S. Dixon for help in identifying specimens.

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# LETTERS TO THE EDITOR

## *DESMARESTIA DUDRESNAYI* LAMOUROUX IN BRITAIN

During the meeting of the British and French Phycological Societies in September 1960, C. den Hartog (Holland) collected a specimen of *Desmarestia dudresnayi* as drift on the island of Herm. Records of this species during the last hundred years have been few and infrequent. It was first found in the British Isles in August 1853 by William Sawers in Moville Bay, Lough Foyle, Co. Donegal (Greville, 1854). Specimens collected at that time were widely distributed and herbarium sheets marked as being specimens of *D. dudresnayi* collected by Sawers are known to be in the herbaria of the British Museum (Natural History Section), le Muséum National d'Histoire Naturelle, Paris, the Royal Botanic Garden, Edinburgh, Trinity College, Dublin, the National Museum of Ireland, the Gatty Marine Laboratory of the University of St. Andrews and the Botany Department of the University of Glasgow. Further records are of specimens dredged near the Lizard, Cornwall, in 1864 (Gray, 1867), off the Eddystone Lighthouse, Devon, in 1895 (Brebner, 1895) and near Inishbofin, Co. Galway in 1899 (Johnson *et al.*, 1899). It was recorded again by Parke (1950) and by the Devonshire Association (1952) dredged off the Eddystone Lighthouse, but since then there has been no other record until the present one.

It seems possible, however, that phycologists investigating sub-littoral algae may come across *Desmarestia dudresnayi*; if so, I shall be very pleased to see any such material and to have details of its occurrence.

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Helen Blackler

## A *COMPSOPOGON* OCCURRING IN THE REDDISH CANAL, NEAR MANCHESTER

The genus *Compsopogon* is mainly tropical and sub-tropical in distribution and its occurrence in temperate waters is, therefore, of some interest. There are two species recorded from Europe, *C. corinaldii* (Menegh.) Kütz., from near Pisa, Italy and a species referred to *C. leptoclados* Mont. from the Reddish Canal, near Manchester, England. The latter species was reported by Weiss and Murray (1909) as one of the alien aquatic plants occurring in the Reddish. They state, "A comparison of the plant with specimens at the British Museum shows that it agrees very closely, both in its macroscopic and microscopic structure, with *Compsopogon leptoclados* Mont., a species which has so far been found only in Guiana."

During the summer of 1957 I gathered some material of this alga, and I have also been able to examine herbarium specimens, as well as others preserved in formalin, from the collection of the late Dr K. M. Drew. A comparison was made between this species and the type specimens of species of *Compsopogon* obtained from Muséum National d'Histoire Naturelle, Paris, and from the Rijksherbarium, Leiden. I found that the species from the Reddish Canal was very different from *C. leptoclados*, but conformed to *C. coeruleus* Mont.

*C. leptoclados* is a very finely and profusely branched alga with a characteristic appearance. The dry thallus (only herbarium specimens were available for study) was greyish green in colour. The main axes were thin, not exceeding 200μ in thickness. The ultimate branches, which were uniseriate, showed rhizoid-like outgrowths from the basal parts of their cells. The last point is a matter of considerable diagnostic importance as this is the only species which exhibits this character. The form from the Reddish Canal shows none of these features. In the latter the thallus is a dark blue-green and is sparingly and irregularly branched. There is but a single main axis, which is rather thick, in some specimens reaching up to one millimetre in thickness. The cells in the ultimate branches are discoid, 9.6 to 19.2μ high and 12.8 to 16μ wide, and in some of the more robust branches may reach a width ranging from 19.2 to 25.6μ. The cortical cells are 25.6–32μ × 16–22.4μ. Monosporangia were seen both on the uncorticated ultimate branches and in the cortex of the older filaments. These were generally about 20μ across. Most of these features are those of *C. coeruleus*, which happens to be also the most widely distributed species. It thus appears that the Reddish Canal represents the northern limit of distribution of *C. coeruleus*.

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V. KRISHNAMURTHY

## REVIEWS

TAYLOR, W. R. *Marine Algae of the Eastern Tropical and Subtropical Coasts of the Americas.* Pp. ix + 870, with 94 plates. University of Michigan Press, Ann Arbor. 1960. Price $19.50

In terms of marine algal distribution the absolute tropics have little meaning. On the eastern side of the Atlantic the latitudinal limits of tropical algae are restricted by the cold waters of the Canary and Benguela Currents; on the western side, however, they are considerably extended by the warm waters of the Gulf Stream flowing north and those of the Brazil Current flowing south. It is this extensive region of the eastern American coast from North Carolina to southern Brazil that is dealt with comprehensively by Professor Taylor in his latest book.

This volume, modestly described by Professor Taylor as a pioneer work, is an expression of the intimate knowledge acquired during thirty years of acute observation and painstaking research and he is to be congratulated on completing what will undoubtedly remain the standard work on the marine algae of this area for many years.

The book begins with an introductory section dealing with the phycological history, geographical distribution and ecology of the area and includes a useful discussion on technique. The main part, however, consists of keys to and descriptions of families, genera and species systematically arranged. The keys are very useful and well-constructed; however, for the benefit of students who will use the book, a brief characterisation of the classes and a scheme giving an over-all view of the classification adopted would have been welcome additions.

760 species, eight of them new ones, are recognised. The descriptions are clearly and concisely executed and are on the whole excellent, but, although authorities for species are given, dates are not and references

are sometimes incomplete. Nomenclature is occasionally somewhat conservative and a number of minor criticisms might be made. For example, Švedelius (*Svensk Bot. Tid.*, **50,** 1–24, 1956) has pointed out that the "epidermis" of Agardh's *Gloiophlaea* is characterised by a complete absence of hyaline vesicles; thus the two species dealt with under that name should have been transferred to Levring's new genus *Pseudogloiophlaea*. Papenfuss (*J. S. Afr. Bot.* **17,** 167–88, 1951) has given convincing reasons why *Taenioma macrourum* Thuret should be called *T. nanum* (Kütz.) Papenfuss, but the former name is adhered to in this work. In the same paper Papenfuss also gave reasons for sinking *Caulerpa vickersiae* Børgesen (a name also retained in the book under review) in *C. ambigua*, though these are perhaps not quite so convincing. Again, Chapman and Ambler (*Trans. Roy. Soc. N.Z.*, **79,** 114–8, 1951) have attempted to show that *Bachelotia fulvescens* (Bornet) Kuckuck (under which name it appears in Professor Taylor's book) is identical with a plant described earlier by Grunow as *Pylaiella littoralis* var. *novae zelandiae* and it would appear that the correct name should now be *Bachelotia novae zelandiae*. It might also have been worth while to draw attention to the relationship between *Derbesia* and *Halicystis* in the way that has been done for *Asparagopsis* and *Falkenbergia*.

The illustrations to accompany the descriptions are collected together at the end of the book and comprise 80 plates. They mainly show external features and are all first rate. It is a great pity, however, that lack of space prevented the inclusion of more details of microscopic structure.

Since there is no comparable flora of any other tropical area, it is inevitable that this book will be used in many regions other than those mentioned in its title. This being so, some indication of world distribution might have been included. The addition of a map showing the position of all the places mentioned in the text would have further enhanced its value.

The book maintains the high standard of production we have come to expect of the University of Michigan Press. During the short time it has been in my possession I have already found it most useful in dealing with West African algae, especially since many tropical and subtropical genera and species are here characterised for the first time in English, and I have no doubt that it will be a constant companion in the future.

G.W.L.

### Desikachary, T. V. *Cyanophyta*. Pp. x + 686 and 139 plates. Indian Council of Agricultural Research Monographs on Algae, New Delhi, 1959. Price £3 10 0

The study of freshwater algae is popular among Indian botanists, as the numerous papers on the algae of that country testify. The earlier work, in the main, was that of Europeans, but in the last 40 years or so the Indians have been active and the number of papers on Indian Cyanophyceae alone is nearing 200. 750 species in 85 genera have now been recorded from India and neighbouring countries, including 170 species which have been found first in India. This represents about half the known species and rather more than half the known genera. That more await discovery seems certain, for most attention has been paid to the freshwater forms and investigation of the marine blue-green algae has lagged far behind.

With so much attention being given to the algae of India, and the blue-greens are probably one of the most popular algal groups there, it will be welcome news to algologists to learn that the Indian Council for Agricultural Research has decided that the time has come for the publication of a series of monographs on the algae of India and neighbouring countries. It is to be hoped that these monographs will cover all the algal groups. The first two to appear are the volume under review and that on the Zygnemaceae by Dr Randhawa.

Dr. Desikachary's monograph contains a short introduction which includes a general account of the morphology and biology of the Cyanophyceae and of their classification and phylogeny. It may be felt that this section and particularly the part devoted to classification, could have been rather fuller. It is true that the section is very fully documented, so that more detailed information can readily be obtained, and the author might reasonably contend that excellent and more extensive treatments are already available in standard works. Nevertheless, a new and authoritative contribution could scarcely have been lacking in freshness and algologists would have welcomed Dr. Desikachary's own views, in more detail, on classification and taxonomy.

The systematic part, which naturally occupies most of the book, follows the usual lines and is very well illustrated by black and white plates. Reference to the keys of some of the genera (e.g. *Oscillatoria*, *Lyngbya*, *Gloeocapsa*) emphasises on what small differences specific distinction in the blue-green algae may sometimes depend. In the present state of knowledge this is probably inevitable; none the less, it is not a satisfactory state of affairs and the author's belief that attention must be given to the physiology and ecology of these plants, as well as to their morphology and cytology, will be fully endorsed by students of the group. We need to know much more about specific and generic variation in the group and for much of this, culture studies will be needed. Nevertheless culture studies must be correlated with studies of variation in nature before their value for taxonomic purposes can be assessed.

F.W.J.

RANDHAWA, M. S. *Zygnemaceae*. Pp. 478, with 520 figures in the text and 11 maps. Indian Council of Agricultural Research Monographs on Algae, New Delhi, 1959. Price £2 10s. 0d.

Dr Randhawa's monograph is one of a series, the compilation of which has been initiated by the Indian Council of Agricultural Research on the Algae of India. This volume was originally intended to treat the Zygnemaceae only of this sub-continent but, as stated in the Introduction, the work developed into a comprehensive treatment of the group and contains descriptions of all the 580 species so far discovered. There can be few groups of plants, or animals, that have been monographed on three occasions in 15 years, as has now been the fate of the Zygnemaceae. Unfortunately one must question the need for this most recent venture in view of the fact that only 46 species have been described since the publication of Transeau's monograph and especially since it is quite clear that the keys, and the descriptions of some 534 species, are taken almost without alteration from this latter monograph. Dr. Randhawa does, however, propose a new, though not revolutionary system of classification based on chloroplast structure. In this the family is divided into four sub-families, these being the Mougeotideae, with single plate-like chloroplasts; the Zygnemoideae with two axile chloroplasts which may be spherical or stellate in shape; the Spirogyrideae, with one or several parietal, spirally arranged chloroplasts; and finally the Sirocladioideae with but one genus, *Sirocladium*, whose three species are all terrestrial and so far have been recorded only from India. These have two plate-like chloroplasts.

In addition to the purely taxonomic part of the work, the first 100 pages are devoted to a historical survey of the study of the Zygnemaceae, followed by chapters dealing with classification; possible relationships with other algal groups; occurrence and distribution (with special reference to the Indian species); cell structure, reproduction; and a sixth chapter outlines the characters used in the identification of species. With reference to this latter chapter, and the one on cell structure, it would seem that Dr Randhawa is regrettably unaware of Dr. Godward's most promising investigations on the cytotaxonomy of *Spirogyra*. Knowledge that the cytological techniques employed are easy to use, coupled with her findings that at least some species are recognisable on the basis of certain cytological characters, raises the hope that by the time the Zygnemaceae are monographed again, well defined cytological characters of vegetative cells will have been established at least for many of the commoner species, and so replace the present necessity to have conjugating material before any identification can be attempted. Even more important it would seem, is the need for a key for the separation of genera to be based on similar cytological characters to replace the present one which depends, for example, on whether or not cytoplasmic residues are left in gametangia, or whether or not these structures are filled with " pectic cellulose colloid " !

A.J.B.

KUSNEZOW, S. I. *Die Rolle der Mikroorganismen im Stoffkreislauf*. Translated by A. Pochmann. Pp. x + 301 with 77 figures in the text. Deutscher Verl. Wissensch., Berlin, 1959.

Dr Pochmann has placed all limnologists in his debt by this translation of Prof. Kusnezow's valuable book published in Moscow in 1952. This has been done in collaboration with Kusnezow and contains additions and emendations. Kusnezow is a leading worker on the microbiology of lakes, while the large amount of Russian work summarised here is scattered through a variety of journals, reports of commissions etc., many of which had a small circulation outside Russia or even within it. Moreover the Russians have contributed much to all aspects of geochemistry. Here, for example, can be found a summary of the classical work done at the Limnological Station of Kossino, which is now unfortunately defunct. Equally classical are the early investigations of Vinberg on production and Perfiliew on bottom deposits. Though chiefly concerned with bacterial processes there is much in this well produced and clearly written book to interest phycologists.

J.W.G.L.

SPARROW, F. K. Jr. *Aquatic Phycomycetes*. Pp. vii + 1187, with 90 text-figures and 929 line illustrations. University of Michigan Press, Ann Arbor, 1960. Price $22.50.

This book is the second revised and enlarged edition of Dr. Sparrow's earlier work on Aquatic Phycomycetes published in 1943. It is primarily intended as a reference book for mycologists. However, since so many of these fungi live on or in algae, both freshwater and marine, algologists should also find it of great value and interest.

The subject matter is clearly and concisely dealt with. The fungi concerned are divided into two major groups, the Uniflagallatae and the Biflagellatae. The Uniflagellatae is composed of the Chytridiales, Blastocladiales, Monoblepharidales and Hyphochytriaceae. The biflagellate orders considered are the Plasmodiophorales, Leptomitales, Lagenidiales and Peronosporales. A single aquatic genus of the Entomophthoraceae, namely *Ancylistes*, is also included. Among these groups, of direct interest to algologists, are the Chytridiales, Lagenidiales, Hyphochytriaceae, *Ancylistes* and part of the Sapropegniales. Together they make up a substantial part of the book.

The taxonomic account of each order is preceded by a description of features of more general interest. Keys are given to the orders, families, genera and in some groups to the species as well. After each species description, the substrata, collectors and countries where found are noted. There is an extensive bibliography of over 1200 papers and additional references up to 1957 have been inserted in the text. Many new illustrations are included in this revised edition. Nevertheless, I feel even more would have greatly added to its value, especially for people who may wish to use the book but who are not familiar with the organisms themselves. Of extreme value to algologists is the excellent and clearly set out index of substrata. The arrangement of this information in the new edition is a great improvement on the earlier work. Now at a glance can be seen the fungi which are recorded on any particular algal species, debris, fungus, animal etc.

Perhaps a word of criticism may be given as regards the structural formation of this book. Approximately 340 extra pages have been added to this volume which now weighs $5^3/_4$ lbs. (cf. 1943, $3^1/_2$ lbs.). However, the page size has remained the same, which makes it cumbersome to use, and the general binding appears inadequate for the weight. After but a few months of moderate use my own copy has come to pieces. I venture to suggest that a slimmer tome with larger page would have been more practical.

Apart from this criticism the book itself is a wonderful achievement. Dr Sparrow has not only put these exciting organisms on the map for a wider public but has provided the beginner in this subject with what may be termed the aquatic mycologist's encyclopaedia. Finally, this should prove to be a source of inspiration to all who study the lower aquatic fungi.

H.M.C.

## CHADEFAUD, M. and EMBERGER, L. *Traité de Botanique Systématique*. Tome I—Chadefaud, M. *Les Végétaux non Vasculaires* (*Cryptogamie*), Pp. xv + 1018, with 713 figures. Masson et Cie, Paris, 1960. Price 185 or 200 NF.

It is a herculean task in these days to write a book of over 1000 pages covering the structure, reproduction and evolution of bacteria, slime fungi, actinomycetes, algae, fungi, lichens and bryophytes. Dr Chadefaud is to be admired and honoured for giving us a treatise which is both comprehensive and coherent. Few of us will feel competent to review so great a work. In the present case only matters pertaining to the algae are considered.

The first 422 pages cover the algae, bacteria and allied forms; there follow over 500 pages devoted to fungi, including lichens, and less than 70 on bryophytes which, one feels, deserve more than 7% of the text. The book ends with addenda, an index of plant names and a *Table des Matières*. The last would be better at the beginning as it consists of chapter and section headings. A general index would have been helpful in a book of this size, particularly when terminology, much of it unfamiliar to many foreign students, looms so large. In order to solve terminological difficulties one must go through the *Table des Matières*; even then there is no certainty that a page reference will be found.

Chadefaud groups the blue-green algae, bacteria and allied groups in the Protocaryotes or Schizophytes. The basic type is an archethallus—" Une simple colonie de cellules que d'abord se multiplient par ses bipartitions végétatives . . .". This view results (fig. 67) in algae such as *Cylindrocystis*, *Zygnema* and *Pleurococcus* being archéthalles. Therefore *Pleurococcus* is primitive in structure while the Volvocales " sont issues de Chlorococcales zoosporinées ancestrales," though, of course, representatives of some of the ancestral types may no longer exist. In the Phaeophyceae and Rhodophyceae there is a progressive evolution from an archethallus or prothallus to cladomes, branched structures with an axis and other branches to second or third orders. In the Chrysophyceae and Chlorophyceae, for example, there is often retrogressive evolution resulting in simple filaments, coccoid or monadine types. On this view the archethallus of blue-green algae is a packet of cells from which are derived, by progressive evolution, the filamentous types and, by retrogressive evolution, the unicellular ones. Similarly, unbranched filaments may arise from branched or heterotrichous ones. Thus the Nostocales are derived from the Stigonematales. It is, then, at once clear that Chadefaud proposes enlivening and invigorating viewpoints.

The algae with nuclei form the Eucaryotes or Phycophytes. They are grouped into Rhodophycophytes (red algae), Chromophycophytes (Propyrrophyceae, Pyrrophyceae, Chrysophyceae and Phaeophyceae) and Chlorophycophytes (Zygophyceae, Euchlorophyceae and Charophyceae).

The Propyrrophyceae consist of two groups, the Pocillophycineae, represented solely by *Pocillomonas* Steinecke, and the Paracryptophycineae, also with only one member, *Chrysophaeum* Lewis et Bryan. Since these monotypic genera represent basic forms it is a pity, as he points out, that so little is known about them. Certainly *Pocillomonas* may be looked upon as dubious and it is its structures which are the basis of his ingenious hypothesis of how other flagellate forms have developed. This hypothesis leads us via the cryptomonads and dinoflagellates to the chrysomonads.

There are many other fascinating ideas, though some may feel that fact and hypothesis are, at times at least, mixed too intimately. Notable is his view that diatoms are basically filamentous. The linear archethallus has the interlocular H-pieces (vide *Tribonema*?) much developed. In *Tabellaria* such archethalli have become partially dissociated and in other genera they are converted into colonies. Thus, we finally reach the great mass of unicellular forms in which the filaments have become completely dissociated.

This book may irritate those whose minds run on " classical " lines and others who have a matter-of-fact or sceptical outlook. Nevertheless it deserves to be read carefully, if only because a belief that such a complete synthesis is as yet impossible may arise from the difficulty of keeping open the doors of one's mind.

The book is well and clearly produced. Mistakes are few and recent work receives full consideration. Nevertheless, though the figures look so clear, their production is open to some adverse comment. Why, for example, cannot other people's photographs be reproduced in a book costing £14–£15? It is sad to see much-admired electron micrographs copied as line drawings. Moreover, is it really necessary to alter other workers' figures, even if such alteration does not lead to any serious distortion? Are not the figures of Pascher and Conrad good enough (to name two who unfortunately are no longer with us)? They certainly look better than the approximate copies which have been made without its being said that this has been done. Sometimes it is not said that the figures are not originals, at others it is said that they are after someone, and we are left to find out for ourselves from which of his, perhaps fifty or more, papers they are derived. At other times they are after "diverse authors" or even simplified, although, in fact, a large number are somewhat modified. To take but three examples, *Dinoclonium* (fig. 133) has the zoospore coming out of the wrong side of the filament and other changes; *Phytodinedria* (fig. 133) has chromatophores put in where they were not depicted and the shapes of those which are depicted somewhat altered, and *Tetragonidium* (fig. 128) has a zoospore combining somewhat diagrammatically the characters of the two zoospores drawn by Pascher. The device of pretending so many were drawn when unilaterally illuminated can lead to the idea that one side is thicker than the other. These may all be small matters but it is a pity to see them in a work of this magnitude.

One may end on a happier note by advising phycologists to read the introduction (pp. I–XV), which is, in fact, a fascinating essay. They may all agree with statements such as " Pour nous, les Algues se situent à la base et au coeur de tout le monde vivant, et les biologistes ne devraient jamais l'oublier," or, " une solide formation algologique devrait être exigé de tous les Botanistes: elle devrait être à la Botanique un peu ce que le latin est aux Humanités." May we commend these sentiments to certain Heads of Departments?

J.W.G.L.

## Freshwater Biological Association. Twenty-eighth Annual Report (for the year ended 31st March, 1960). Price 4s.

This report contains the welcome news that the Association has at last been able to make a start in planning a Southern Station for work on rivers. Some land and fishing rights have been bought at East Stoke, near Wareham, and once a grant to build, staff and equip a laboratory has been obtained rapid progress may be expected.

Several cores of sediments have now been analysed and a fairly coherent picture of the chemical changes in the waters and catchment areas of the Lake District lakes is emerging. This will be of great assistance in analysing the post-glacial history of the diatoms. Further basic data about the chemical content of plankton algae are given. An experimental study of the growth of the epiphytic *Tabellaria flocculosa* var. *flocculosa* has given support to inferences made previously from observational studies on natural populations. It has been possible to compare estimates of the productivity of *Asterionella* in spring based on photosynthetic behaviour, the development of the standing crop and the depletion of the silicon in solution in the water. The oxygen balance of higher plants in streams has been examined in detail in order to evaluate the contributions of photosynthesis and respiration. Several new or interesting chytrids are recorded.

During the year some 26,000 illustrations were added to the Fritsch Collection which, it is estimated, now contains some 145,000 pictures of algae. The present financial grant for this ends in March 1961.

The report closes with a list of limnological papers published in Britain in 1959, about 50 of which concern algae.

J W G.L.

# REQUESTS FOR RESEARCH MATERIAL

Professor P. Kornmann, Biologische Anstalt, Helgoländ, W. Germany, would like to have specimens of *Acrosiphonia* from the coasts of Britain in order to compare British and Helgoländ material. The older stages of *Acrosiphonia arcta* will be especially welcomed.

Dr G. Russell, the Marine Biological Station, Port Erin, Isle of Man, would like to have from any source specimens belonging to the genus *Streblonema*. These should be sent air-dried or preserved in formalin-acetic-alcohol.

Professor V. Krishnamurthy, Department of Biology, Thanjavur Medical College, Madras State, India would like to have specimens of any Bangiophycid alga from any part of the world. Material fixed in F.A.A. will be particularly useful ; but specimens in formalin or as herbarium mounts will be welcomed.

# OBITUARIES

Members of the Society will have learned with great regret of the death of **Professor T. A. Stephenson,** D.Sc., F.R.S., on April 3rd, 1961 at the age of 63 years. Educated at Kingswood School, Bath, Professor Stephenson entered the University College of Wales, Aberystwyth as an undergraduate in 1914, but ill-health prevented his completion of the degree course. Subsequently, however, he obtained a research degree and was later awarded the D.Sc., of the University of Wales. From 1919–22 he was engaged in research under the auspices of the D.S.I.R., and was a Lecturer in Zoology in University College, London from 1922-30. He was in charge of the Reef section of the Great Barrier Reef expedition during 1928 and 1929.

From 1930–40 Professor Stephenson held the Chair of Zoology in the University of Cape Town, where he carried out, with various colleagues, a survey of 2000 miles of the coast of the Cape Province. He then returned to Britain and became the Professor of Zoology at the University College of Wales, Aberystwyth, a post which he held until his death. He was elected to a Fellowship of the Royal Society in 1951.

Professor Stephenson had travelled extensively and has written a number of papers in scientific journals as well as producing a very beautiful monograph, in 2 volumes, on British Sea Anemones. His papers were superbly illustrated, often in colour, with outstanding skill and he has made an especial contribution to our knowledge of marine ecology, inasmuch as he has considered the inter-relationship and relative positions on the shore of both animals and plants. An extensive work on a comparative study of the world's coasts which would have embodied the results of his wide researches is unfortunately unfinished.

It will be recalled that Professor Stephenson gave the opening address to the symposium on intertidal ecology held during the International Seaweed Symposium in Galway. Our sincere sympathy is extended to Mrs Stephenson in her bereavement.

L. N.

Her friends will have heard with a deep sense of personal loss of the sudden death of **Dr Nicolai** on the 13th March, 1961 at Hilversum at the age of 60.

Marie Françoise Emilie Nicolai was a graduate of the University of Leiden. After the war she was working at the Dutch Fibre Research Institute when Professor R. D. Preston was looking for someone to co-operate in biophysical research on the walls of algae. Dr. Nicolai's training and experience were ideally suited and in 1947 she joined the staff of the University of Leeds. She worked mainly with *Cladophora*, which involved a preliminary sorting-out of the difficult relationships of *Cladophora* and *Spongomorpha* species, and *Chaetomorpha*. During this work she obtained beautiful X-ray diagrams and electron miscroscope photographs of the fibrous wall structure and even of the pattern at the apex of a sporeling—a testimonial to the neatness and efficiency of her culturing, handling and treatment of material. She was joint authoress of papers on wall structure. As a lecturer in Leeds she was also responsible for some teaching of biophysics and algology.

In 1957 she left Leeds to become the first Director of the Dutch Hydro-biological Institute. Her work was well known in Government and scientific circles in Holland and she was invited and pressed to accept this position. After much investigation the site at Nieuversluis was chosen, laboratories equipped and a small staff appointed. Research along various lines was started and Dr Nicolai herself was surveying the algal population. It is sad that the cerebral haemorrhage from which she died prevented her from seeing more of the results of her labours. It seems possible that the privations, strains and anxieties of the war years may have contributed to her death.

Dr Nicolai was in her element on the seashore and she much enjoyed the phycological excursions to Roscoff, Galway and Banyuls as well as visits to Robin Hood's Bay, Cullercoats and St. Mary's Island. She will be sadly missed at the forthcoming phycological meeting. She was a wonderful linguist and it fascinated me at Roscoff to see the ease with which she could turn from Dutch to fluent English, French or German and I have even known her to tackle Italian or the Swiss-German dialect !

Above all Dr Nicolai will be remembered for her intrinsic qualities, her outstanding graciousness, friendliness and sympathetic understanding. People were drawn instinctively to her and I doubt that there was anyone with so wide a circle of friends from all walks of life, or anyone with so many who valued her as one of their most-loved friends. We were proud to know how much Dr Nicolai loved England and had made hersel " one of us." Leeds drew her back for frequent visits and I like to remember her, as I saw her in January, happily chatting to her friends in Leeds.

L.I.S.

We record with regret the death of **Professor Curt Hoffmann** at Kiel on June 1st, 1959, at the age of 61 years.

Professor Hoffmann occupied a Chair at the " Institutes für Meereskunds " of the University of Kiel, where, in addition to teaching, he pursued his researches on the ecology and physiology of marine algae. He published a number of papers in scientific journals and his larger works included " Vegetation der Nord und Ostsee " and " Pflanzenwelt der Schlei." He attended the International Seaweed Symposia and was much interested in recent developments in seaweed utilisation.

Our sympathy is extended to Frau Hoffmann, who accompanied him on his overseas visits.

**Professor Nils Eberhard Svedelius** died on August 2nd, 1960, at the age of 87 years. He was attached to the Royal University of Uppsala for the whole of his academic life and occupied the Chair of Botany from 1914 until his retirement in 1938. He travelled extensively and studied the ecology of both littoral and sub-littoral algae as well as making important investigations on the development and cytology of the Florideae. He was honoured by many universities and learned societies in Europe and America and was elected an Honorary Fellow of the Royal Society of Edinburgh in 1955.

# BRITISH PHYCOLOGICAL SOCIETY

## (a) FIELD MEETING AT GUERNSEY, CHANNEL ISLANDS

### September 1st–8th 1960

Groupant une cinquantaine de participants britanniques ou étrangers, cette réunion fut particulièrement réussie. Elle avait été préparée par le Dr W. E. Jones et le Dr P. S. Dixon qui nous a guidés avec entrain et compétence au cours des diverses excursions.

Grâce à M. Day, headmaster of the Queen Elizabeth College, les participants ont pu disposer de laboratoires suffisamment vastes pour permettre le tri et la préparation de leurs récoltes, tout en échangeant leurs points de vue sur les espèces rares ou critiques.

La British Phycological Society avait eu l'amabilité d'offrir à la Société Phycologique de France de se joindre à elle pour cette réunion et une douzaine de phycologues français avaient répondu à cette invitation. Ils ont emporté de leur séjour à Guernsey un excellent souvenir, non seulement de la beauté de cette île et de ses richesses phycologiques, mais aussi de l'amical accueil que leur ont fait leurs collègues britanniques et dont ils ont été très touchés.

Par sa situation géographique et la diversité de ses côtes, l'île de Guernsey présente un intérêt tout particulier : les phycologues britanniques ont pu, au cours des excursions, y récolter un certain nombre d'espèces méridionales plus rares sur les côtes anglaises et les phycologues français comparer la végétation marine avec celle des côtes françaises voisines.

Dans une réunion tenue au Queen Elizabeth College, le 1er septembre au soir, sous la présidence du Dr Mary Parke, le Dr P. S. Dixon, au cours d'une conférence introductive, nous a présenté de belles photographies en couleur montrant les divers aspects des côtes de Guernsey et le Dr Davy de Virville, une série de photographies relatives à l'écologie des algues de cette île.

Le 3 septembre, au Royal-Hôtel, les phycologues étrangers furent les invités de leurs collègues britanniques à une réception très cordiale qui permit à tous de renouer connaissance.

Les excursions suivantes, tant sur les côtes de Guernsey que dans les îles voisines, ont été faites :

2 septembre : *Portelet Bay* près de Pleinmont à la pointe S.W. de Guernsey. Dans cette station assez abritée avec un peuplement dense de Fucacées (*Fucus vesiculosus* et *F. serratus*), nous avons récolté quelques espèces intéressantes : *Halopitys incurvus*, *Stilophora rhizodes* ainsi qu'un individu de *Codium fragile* ssp. *tomentosoides* dans une cuvette de niveau supérieur.

3 septembre : *Bordeaux Harbour* -sur la côte E. de l'île. Station plus riche que la précédente. Dans un chenal séparant un îlot de la côte, on a pu rècolter de nombreuses Floridées (*Bornetia secundiflora*, *Crouania attenuata*, *Corynospora pedicellata*, *etc.*).

4 septembre : Aucune excursion générale n'était prévue pour cette journée de dimanche, les participants ont effectué des excursions individuelles. Certains d'entre eux sont allés à Petit Bot Bay et y ont récolté en particulier *Gigartina pistillata*.

5 septembre : *Ile de Sark :* Favorisée par un temps magnifique, cette excursion fut peut-être la plus belle de toutes. Une partie des participants explora la Grande Grève, au pied de la Coupée, et y ont récolté *Platoma marginifera :* Venus Pool, à l'extrémité Sud de Little Sark, est une station fortement battue avec de larges et profondes cuvettes ou

furent récoltées en particulier *Schizymenia dubyi*, *Grateloupia filicina*, *Ulva olivacea*, *Nemalion elminthoides*, etc.

6 septembre : *Ile Lihou :* Cet ilot, situé sur la côte W., est accessible par une chaussée à marée basse. Sur la côte exposée au large, les algues sont bien développées en particulier dans les cuvettes sableuses entre les rochers ou l'on a récolté : *Ahnfeltia plicata*, *Helminthocladia calvadosii*, *Gigartina pistillata* et, sur les rochers, *Codium tomentosum* très abondant. Entre l'île et le Fort Saumarez, le long de la chaussée, s'étendent de vastes peuplements de *Cystoseira* (*C. foeniculacea*, *granulata*, *tamariscifolia*, *baccata*) et, à niveau plus élevé, C. *myriophylloides*.

7 septembre : *Herm*. Les récoltes ont été faites au S. de Shell-beach. Sur les rochers sableux, on a trouvé *Padina pavonia* et *Scytosiphon lomentaria :* Plus bas, les feuilles de *Zostera marina* étaient couvertes de larges touffes d'*Antithamnion sarniense*. A basse mer, on a récolté en particulier *Gymnogongrus norvegicus*, *Kallymenia reniformis*, *Codium vermilara*, *Laminaria ochroleuca*, etc. en épave, *Scinaia turgida*.

La Liste des espèces récoltées au cours des excursions, établie par P. S. Dixon, donnera une meilleure idée que ce court compte-rendu de l'intérêt et de la variété de la végétation marine de Guernsey.

J. Feldmann

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## (b) WINTER MEETING AT ROYAL HOLLOWAY COLLEGE, LONDON

## January 5th–6th, 1961

The annual winter meeting was held on January 5th and 6th, 1961, at Royal Holloway College, University of London, by kind permission of the Principal and of Professor F. W. Jane. About 60 members and guests attended.

The meeting opened on Thursday afternoon, when Professor Jane, after welcoming the Society to the College, presided at a session of papers (see Abstracts below). Exhibits relevant to some of the papers read at the meeting were on view in the Botany Department; an additional exhibit on a cytological study of some Cladophorales was shown by Mr R. J. Patel and Dr M. B. E. Godward (Queen Mary College).

During the evening a Society Dinner was held at the College and was attended by 35 members and guests. The President-elect, Professor G. E. Fogg, expressed the thanks of the Society to the College and Professor Jane replied.

On Friday, January 6th, proceedings opened with a series of papers, under the chairmanship of Dr M. A. P. Madge. Later, Dr M. B. E. Godward, in the chair, welcomed the President, Dr Mary Parke, who then gave her Presidential address on " Some remarks concerning the class Chrysophyceae " (see p. 47). Mr R. Ross proposed a vote of thanks to Dr Parke for her address and for her work on behalf of the Society during her term as President.

During the afternoon the Ninth Annual General Meeting was held (see Minutes below), and the meeting closed with a final session of papers under the chairmanship of Professor Fogg.

# ABSTRACTS OF PAPERS READ AT THE WINTER MEETING, 1961

1. Dr M. A. P. Madge (Royal Holloway College, London)

## Resting zygotes in the Chlorophyceae, with special reference to *Carteria eugametos* Mitra

In her survey of algal life-histories, Drew (1955) argues that the resting zygote, or hypnozygospore, found in many freshwater Chlorophyceae should be regarded as a distinct somatic phase in the life-cycle. She refers to the period of metabolic activity which such zygotes undergo when they accumulate food, increase in size, become very thick-walled, and enter on a long resting period. She makes a sharp distinction between zygotes which develop into such hypnozygospores and those which germinate immediately to give rise to diploid plants.

While it is true that zygotes formed inside a cell of the parent plant (e.g. *Oedogonium*, *Spirogyra*) appear to be fairly consistent in their formation and germination and can fairly be called hypnozygospores, the same is certainly not always so in zygotes which have a preliminary period of motility. In *Carteria eugametos* Mitra there is a lateral conjugation of motile gametes to give a zygote which, at least in culture, shows great versatility in its behaviour. It can exist in a motile condition for weeks and divide to release motile swarmers while still showing its double nature by its shape; it can escape as a naked protoplast, round off and form a non-motile thin-walled cell which may germinate at once; or it may form a hypnozygospore and enter on a resting period lasting for at least a year. On germination such hypnozygospores give rise to 4, 8 or 16 swarmers.

It would appear that in *Ulothrix zonata* also the motile zygote can behave in different ways. According to Gross (1931), it can germinate within 24 hours of formation; it can form a spherical hypnozygospore which germinates after about a month to form four aplanospores (Klebs, 1896); or it can form an attaching rhizoidal outgrowth (Dodel, 1876; Lind, 1936, for *U. rorida*), when it may or may not become thick-walled and may rest for about a year before germinating to give a varying number of zoospores (Dodel, 1876).

In many freshwater Chlorophyceae where the zygote has a preliminary period of motility, there is no detailed information about its later stages. In certain marine species it germinates to give a diploid thallus which is isomorphic with the haploid plant.

Interpretation of life-histories becomes increasingly difficult when motile zygotes become attached before entering on a resting stage, as they do in the *Codiolum* stages of such marine algae as *Urospora* and *Spongomorpha* (Jorde, 1933; Fan, 1959). Until we know the facts of the behaviour and cytology of these various genera, it is impossible to make any rigid classification of zygote behaviour in the Chlorophyceae, and it may be advisable to refrain from using the terms diphasic or heteromorphic for life-histories which include a resting zygote.

References
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Fan, K. C., 1959. *Bull. Torrey bot. Cl.*, **86**, 1.
Gross, I., 1931. *Arch. Protistenk.*, **73**, 206.
Jorde, I., 1933. *Nytt Mag. Naturv.*, **73**, 1.
Klebs, G., 1896. *Bedingungen den Fortpflanzen bei einigen Algen und Pilzen.* Jena.
Lind, E. M., 1936. *Ann. Bot., Lond.*, **50**, 863.

2. Mr A. G. A. Karim (University of Khartoum) (read by Professor Jane)

### The algal flora of some Thames valley gravel-pits

The algae of two pairs of Thames valley gravel-pits were studied over a period of 12–15 months. In each pair, one pit was less than three years old and the other was more than 15 years; in each pit, gravel digging with large mechanical grabs had created a region of more or less permanently disturbed water, while the rest of the pit was relatively undisturbed.

A total of 275 species and varieties of algae were recorded, of which 35 were found only in the new pits and 145 only in the old ones. The old pits had a greater variety of algae, but the estimated total population was larger in the new ones.

3. Dr J. H. Evans (Royal Holloway College, London)

### Some aspects of six months' phycological research in central East Africa

Around Buvuma Island and Pilkington Bay, Lake Victoria, and elsewhere, the diurnal fluctuations in the direction and strength of the wind are important factors in determining the vertical and horizontal distribution of the phytoplankton, notably of *Melosira* spp. A sampler was devised so that collections could be made with nets facing any desired direction. With it, the direction and speed of a current could be determined. Drifts of Cyanophyceae and *Melosira* were followed successfully, even when the current velocity was less than 5 cm. per second.

On Lake Kioga, transects were made by lake steamer, and marked changes in silicate, sulphate and phytoplankton were found.

In view of the recorded shortage of sulphate in this region (Beauchamp, 1953; Fish, 1956), it was of interest to find by culture experiments that the substance limiting the growth of *Melosira* was neither sulphate nor nitrate, but phosphate.

These investigations were carried out in the course of work at the East African Fisheries Research Organization at Jinja, Uganda, under a Colonial Office Research Fellowship and, in part, with the co-operation of Dr J. F. Talling.

References
Beauchamp, R. S. A., 1953. *Nature, Lond.*, **171**, 389.
Fish, G. R., 1956. *E. Afr. agric. J.*, **21**, 152.

4. Dr Mary Campion (University College of North Staffordshire)

### Snail shells as a source of epizoic algae

The shells of freshwater snails offer a fairly representative selection of the algae available in any body of water.

From snail shells collected at varying times of year, from still and running water, in districts ranging from Middlesex to Cumberland and Westmorland, about 120 algae have been cultured. Detailed taxonomic studies were not attempted, but the forms separated included 39 of *Oedogonium*, 21 of *Mougeotia*, 30 of *Stigeoclonium* and 16 belonging to genera of the Ulotrichales. Variations in form, roughness or age of shell appeared to have no positive influence on the settlement of the algae, nor did the shells appear to exert any attractive influence, though in one collection the cells of *Oedogonium alternans* were found to be 1.8 times bigger on *Planorbis corneus* than on near-by water-plants.

5. Miss M. P. Hare (College of Technology, Bristol)

### Characters commonly used in the identification of certain species of *Hormidium* and related genera

A study of clonal cultures of *Hormidium*, *Ulothrix* and *Stichococcus* has shown that some of the characters used to distinguish between genera and species vary considerably under different conditions and are therefore unreliable as taxonomic criteria. Cultures grown in soil extract, Knops and Molischs mineral nutrient solutions showed that:

1. The size of the chloroplasts varied considerably. Of the eight species used, two had very small chloroplasts in relation to cell size when collected (*Hormidium* type). In culture, one of these, *Stichococcus scopulinus*, regularly showed large chloroplasts (*Ulothrix* type) in all culture solutions; the other, *Hormidium rivulare*, showed large chloroplasts in soil solution only. Four others, *Ulothrix variabilis*, *H. flaccidum*, *H. subtile* and *H. nitens*, all of which had large chloroplasts at collection, showed small chloroplasts when grown in mineral culture solutions but large ones in soil extract. There was no significant difference in chloroplast size in clones of the other two, *U. subtilissima* and *H. lubricum*.

2. Formation of a silky film of floating filaments in culture is more widespread than has previously been reported. It occurs in all the species cultured except in *U. subtilissima* and *H. rivulare*, but is not formed in all media. *H. subtile* forms floating filaments only in Knops solution, and *H. flaccidum* only in soil extract.

3. Fragmentation is a fairly constant character. *H. nitens* and *H. lubricum* fragment most frequently and are often found as filaments of less than 10 cells. *H. rivulare*, *H. subtile* and *H. variabilis* fragment but slightly and generally occur as filaments of a few hundred cells. *H. rivulare* does not fragment at all; this is in agreement with published records. Only *H. subtile* shows any variation, as cultures in soil extract do not fragment whereas those in mineral nutrient solutions do so.

6. Mr J. E. Ridley (Metropolitan Water Board, London)

## Recent development of dissolved-oxygen recording apparatus

In many limnological investigations, knowledge of the dissolved-oxygen content of the water is of considerable importance. The automatic and near-continuous recording apparatus recently developed for laboratory and field use (Briggs *et al.*, 1958; Ridley *et al.*, 1960; Parker, 1960) may facilitate the study of thermal-density-viscosity gradients in lakes and reservoirs. The wide-bore polarographic equipment of Briggs *et al.* (1958) recently installed at the Metropolitan Water Board's King George VI reservoir enables a single test to be completed every five minutes, and the instrument functions unattended for at least 2000 determinations. The record shows in great detail the frequency of oscillation of the thermocline (Ridley and Thurley, 1960).

The development of such apparatus suggests that similar instruments might be designed for the automatic and continuous recording of much of the physico-chemical information required by ecologists.

References
Briggs, R., Dyke, G. V., and Knowles, G., 1958. *Analyst*, **83** (986), 304.
Ridley, J. E., Elliott, D. B. L., and Oaten, A. B., 1960. *Analyst*, **85** (1012), 508.
Ridley, J. E., and Thurley, B. L., 1960. *Instrum. Engr.*, **3** (2), 25.
Parker, W. J., 1960. *Instrum. Engr.*, **3** (1), 12.

7. Dr G. Russell (Marine Biological Station, Port Erin, Isle of Man)

## The taxonomic status of *Pylaiella rupincola*

Kylin (1937) separated *Pylaiella rupincola* (Aresch.) Kylin from *P. littoralis* (L.) Kjellm. on the grounds of (i) the mainly lithophytic habit of *P. rupincola* in contrast with the mainly epiphytic habit of *P. littoralis*; (ii) the larger looser form of *P. littoralis* and the smaller (under 5 cm.) form of *P. rupincola* with its marked cable rolling; (iii) differences in life-histories, *P. littoralis* showing regular alternation of sporophyte and gametophyte generations, and *P. rupincola* being known only in the sporophyte phase.

Material in culture and specimens gathered from the shores of St. Andrews, Scotland and from Kristineberg, Sweden, showed the following similarities. (i) *P. littoralis* at St. Andrews might be epiphytic or lithophytic, and the lithophytic plants were identical in appearance with *P. rupincola*. (ii) There was no significant difference between the two in cell size, sporangial size, or pattern and angle of branch emergence. (iii) Zoospores from unilocular sporangia on Swedish *P. rupincola* germinated in culture, and after about eight weeks developed into a fertile gametophyte generation bearing terminal plurilocular gametangia; when subcultured, these gametophytes gave rise to a second generation bearing intercalary unilocular sporangia, either alone or with intercalary plurilocular sporangia —a sequence similar to that in *P. littoralis* at St. Andrews.

It is therefore suggested that there are no grounds for distinguishing the two species and that the name *P. rupincola* should be abandoned.

Reference
Kylin, H., 1937. *Lunds Univ. Årsskr.*, N.F., Avd. 2, **33** (2), 3.

8. Mr D. G. Rayns and Dr M. B. E. Godward (Queen Mary College, London)

### Cytology of colonial Volvocales of south-eastern England

A survey of the chromosomes of some colonial Volvocales found in south-eastern England has shown that they are normal in possessing a localised centromere and in being associated with a spindle at metaphase. But round each chromosome of *Volvox aureus* there is a wide, clearly delimited zone which is unstained by acetocarmine, a feature best seen at anaphase. In *Volvox globator*, the nucleolar-organising chromosome is seen attached to the, nucleolus during interphase, and this may be the body described by Cave and Pocock (1951) as being attached to the nuclear membrane in American species of *Euvolvox*.

Chromosome numbers now recorded for the group are:

| | | | |
|---|---|---|---|
| *Gonium pectorale* | 17 | *Eudorina elegans* | 16 (differs from previous records) |
| *Gonium sociale* | 10 ± 1 | *Volvox aureus* | 14 |
| *Pandorina morum* | 10 | *Volvox globator* | 5 |

The majority of algae so far investigated show primary mitotic peaks in the dark phase; but, in a 24-hour cycle of 18 hours illumination and 6 hours darkness, the peak of mitotic division for *Eudorina elegans* was found towards the end of the light period. These cultures showed nuclear division to be completed in four days, with maximum colony numbers in six days. It has also been established that nuclear division of a clonal colony of *E. elegans* is non-synchronous; that nuclear division within a colony is non-synchronous, and that nuclear division of a cell and its daughters is strictly synchronous from the first to the final division. Further, there are greater numbers of the penultimate division than any other. The peaks of the division phases of mitosis are approximately coincident, and a rapid division time (about 10 minutes) is indicated (see Cave and Pocock, 1951).

Reference
Cave, M. S. and Pocock, M. A., 1951. *Amer. J. Bot.*, **38**, 800.

9. Dr J. D. Dodge and Dr M. B. E. Godward (Birkbeck College and Queen Mary College, London)

### Experimental evidence of the unusual nature of the Dinophycean nucleus

Cytological observations of dividing nuclei have suggested that in the Dinophyceae the nucleus differs in some important respects from that of higher plants and animals. In particular, no evidence has been obtained to indicate the presence of spindle or centromere. Experiments were carried out in an attempt to elucidate this problem.

Mitotic inhibitors, which normally interfere with the function of the spindle, were used in order to try to prove the presence or absence of a spindle in these organisms. Colchicine was applied in concentrations of 0.05 2.0% to *Prorocentrum micans* and *Peridinium trochoideum*. Neither with this nor with any of the other inhibitors used (para-dichlor benzene, 8-hydroxy quinoline, acenapthene and α-mercapto ethanol) were the usual effects of C-mitoses or polyploid nuclei exhibited; it may therefore be concluded either that no spindle is present or that it differs considerably from that of other organisms.

X-rays were used in investigating the centromere problem. It was found that, after high doses of 4,000 rads and over, numerous chromosome fragments were produced, their size depending on the magnitude of the dose. In the next nuclear division these fragments passed into the two daughter nuclei, and were seldom lost as small acentric fragments of angiosperm chromosomes would have been. This indicates that no normal localized centromere is present. Since the chromosomes carry out their anaphase separation at right angles to the plane of division, this seems to preclude the possibility that they are polycentric or have diffuse centromeres.

Observations with the electron microscope have shown that the chromosomes of *Prorocentrum micans* are composed of fine fibrils about 150 Ångstrom units in diameter which seem to be arranged in a definite pattern. An organization of this type has not yet been found in the chromosomes of higher organisms.

10. Dr R. W. Butcher (Fisheries Laboratory, Burnham-on-Crouch)

### Taxonomy of the Cryptophyceae

The Cryptophyceae comprise a well-defined group of largely motile unicellular organisms, the non-motile phase (*Phaeoplax*) of which is very rare and impermanent. They are as a rule characterized by two almost equal homodynamic flagella, and a furrow or groove on one surface which at times deepens into a tubular gullet. The flagella in all cases so far examined are stichonematic, while the ultramicroscopic sections show that they arise from the base of the furrow.

In contrast to most other large groups, the range of colour is extremely wide, blue. blue-green, green, yellow, brown and red specimens having been recorded. This colour range is inconsistent and varies within species, but there appear to be a green blue–green blue range and a separate yellow–green brown red range. The only constant and reliable structure seems to be the furrow-gullet complex. In certain cases this is a shallow simple groove (*Hillea*), in others it is deeper with the sides lined with tuberculate structures known as trichocysts. These are in two simple rows in *Chroomonas*. In *Cryptomonas* the furrow closes into a tube or gullet which is lined with several rows of trichocysts. In *Hemiselmis* the furrow is in the short axis, while in all the others mentioned above it is in the long axis.

Other inclusions in the cell are pyrenoid, stroma starch, and (at times) a stigma. A series of three-day cultures of four different species demonstrated clearly the variability and inconsistency of these structures, as well as the changing colour of a single organism.

11. Dr J. K. Spearing (Sir John Cass College, London)

### Vital staining of *Phormidium retzii*

Living cells should be studied in detail before investigations are undertaken with vital dyes. All the dyes so far used are more or less toxic and produce many types of artifacts. “ Metachromatic corpuscles,” however, are not formed by precipitation from stained vacuoles; the larger “ central granules ” and smaller “ microsomes ” are apparently preformed bodies. The chromatin apparatus usually stains deeply in the post-vital stage. Neutral red chloride (100 p.p.m.) may pass into a cell via the cross-wall at one end only. With Nile blue A sulphate (6.8 or 1 p.p.m.) a ring of small deep-blue dots may appear along the line of junction of the septum with the lateral wall.

Vital staining with the dyes concerned is therefore not a reliable method of investigating the cytology of blue-green algae.

12. Dr A. R. A. Taylor (University of New Brunswick, Canada)

## Marine algae of Canada's Maritime Provinces

Bell and MacFarlane (1933) divided the combined coasts of New Brunswick, Nova Scotia, and Prince Edward Island into three phycological areas: (i) the *Atlantic Coast*, (ii) the *Bay of Fundy*, (iii) the southern *Gulf of St. Lawrence.* The marine flora and littoral ecology of each of these areas were illustrated with coloured slides. The marine flora resembles that of British shores although fewer species have been recognized.

The region is particularly interesting because it is a meeting-place of southern forms from warmer waters and of species found in arctic waters. During diving operations with the Fisheries Research Board of Canada, extensions in range of several species were found which illustrate this. *Dasya pedicellata* (C. Agardh) C. Agardh and *Griffithsia globulifera* Harvey were both found in inlets at Prince Edward Island at depths of 6–10 feet below M.L.W.S., and *Scinaia furcellata* (Turner) Bivona was found at depths of 30–45 feet below M.L.W.S. off the north coast of Prince Edward Island. The warm summer temperatures around Prince Edward Island (rising to 25°C in the inlets) may account for the northward extension of these species which have not been previously reported north of Massachusetts. On the other hand, *Dilsea integra* (Kjellman) Rosenvinge, not previously reported south of northern Labrador (Wilce, 1959), was collected with *Scinaia furcellata* at depths of 30–45 feet off Prince Edward Island. *Tilopteris mertensii* (J. E. Smith) Kützing was collected near Halifax, Nova Scotia, at a depth of 12 feet; this is another new northern limit for the North American east coast.

References
Bell, H. P., and MacFarlane, C., 1933. *Canad. J. Res.*, **9**, 265; 280.
Wilce, R. T., 1959. *Bull. nat. Mus. Can.*, No. 158.

# MINUTES OF THE NINTH ANNUAL GENERAL MEETING

The Ninth Annual General Meeting was held on Friday, 6th January, 1961, with the President, Dr Mary Parke, in the chair. There were 51 members present.

1. The **Minutes** of the Eighth Annual General Meeting, held at Bedford College, London, on 5th January 1960, which had been circulated in this *Bulletin*, Vol. 2, No. 1, were approved.

2. **Report of Hon. Secretary for the year 1960.** (*a*) *Meetings.* During the year two general meetings were held—the winter meeting (the Eighth Annual General Meeting) at Bedford College, London, on 4th and 5th January (see report in this *Bulletin*, Vol. 2, No. 1), and a seven-day Field Meeting based at St. Peter Port, Guernsey, 1st–8th September. The Field Meeting, a most successful joint meeting with the Société Phycologique de France, was attended by over fifty people. (For a report of the meeting see p. 96.)

   (*b*) *The* 1960 *Council* met on three occasions: on 5th January at Bedford College, London; on 4th September at Elizabeth College, St. Peter Port, Guernsey; and on 5th January 1961 at Royal Holloway College.

   (*c*) *The Subcommittee for Marine Algal Check-list and Flora* report as follows:

   (i) The Nature Conservancy has made a substantial grant to the Society to enable a research assistant to be employed for three years to further the work of the Society in producing a new Flora of British Marine Algae. The post will be advertised, and the assistant will work under the direction of Dr P. S. Dixon at the University of Liverpool; the main objective will be to produce the volume on Rhodophyta as soon as possible.

   (ii) During the year the first two parts of " Studies on marine algae of the British Isles " have been published in the *Journal of the Marine Biological Association of the United Kingdom*, Vol. 39. Reprints have been bought by the Society and may be purchased from Dr P. S. Dixon, Hartley Botanical Laboratories, The University, Liverpool, 3.

   (iii) Following the production of these Studies, a few minor emendations to the schedule of instructions for this series were found to be necessary. New revised schedules will soon be circulated to all members of the Society, and the subcommittee appeal to all members who can do so to help forward this work by producing for publication similar studies of any genus or species of marine algae. Full information about the scheme may be obtained from Dr P. S. Dixon.

   (iv) The subcommittee intends to produce in the next few years a revised Check-list of British marine algae, to bring up to date the preliminary Check-list published by Dr M. W. Parke in 1953.

   (v) In connexion with the preparation of the official lists of marine algae collected at Field Meetings of the Society, Council has agreed to the following proposal: " In the interests of accuracy and uniformity, it is requested that the lists of marine algae collected at organized Field Meetings of the Society should be submitted before publication to the Subcommittee for Marine Algal Check-list and Flora. It is envisaged that specimens, particularly of critical groups, will also be kept for examination."

   (*d*) *Membership.* During the year the membership increased from 122 to 145. It is hoped to publish a fully revised list of members in the 1962 issue of this *Bulletin*.

3. **Report of Hon. Treasurer.** Dr M. T. Martin presented and explained the Income and Expenditure Account and the Balance Sheet for the year ended 2nd November 1960 (see copy on p. 107). For the first time the accounts showed a deficit on the year's running, but the financial assets are still reasonable and the Society has stocks of Bulletins and reprints for sale.

4. **Report from Editor of British Phycological Bulletin.** Dr E. Conway reported that No. 1 of Vol. 2 of the *Bulletin*, in new printed format, was circulated to 144 members in October 1960. In addition, 48 libraries (including 15 overseas) now receive the *Bulletin*. Only ten complete sets of Vol. 1 were now left (for sale to libraries). To complete Vol. 1 an index has been compiled, and will shortly be circulated to members.

   The reports of the Secretary, Treasurer and Editor, were adopted.

5. **Subscription.** Dr Martin stated that, in view of the deficit in the accounts for 1960, Council had considered whether or not the membership subscription should be increased, but had recommended that the subscription should be left at £1 for at least another year. The meeting agreed to this recommendation.

6. **International Phycological Society.** An International Phycological Society was formed during 1960, largely owing to the efforts of Dr P. C. Silva, of the University of California. Professor G. E. Fogg (British representative) outlined the aims of the new Society, which would produce a journal to be called *Phycologia*, the first issue of which would appear shortly.

7. **1961 Field Meeting.** The Assistant Secretary, Dr W. E. Jones, reported that the 1961 Field Meeting would be largely a freshwater meeting, based at Wymondham College, Norfolk. After some discussion it was agreed that the dates for the meeting would be 9th–16th September.

8. **Election of Auditors for 1961.** It was unanimously agreed that the present two auditors (Dr D. J. Crisp and Dr J. K. Spearing) be re-elected for 1961.

9. **Election of Officers and Members of Council for 1961.** Officers and Members of Council were elected for 1961 (see p. 46). It was agreed that in future members co-opted to Council to fill a vacancy for one year should not be debarred from immediate renomination to the same office. The rules of the Society will be amended at the next Annual General Meeting to make this point clear.

Dr Parke thanked those present for their attendance, and relinquished the chair to the new President, Professor G. E. Fogg.

H. T. Powell, *Hon. Secretary.*

# BRITISH PHYCOLOGICAL SOCIETY

## INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED NOVEMBER 2ND, 1960

| *Expenditure* | | |
|---|---|---|
| Printing 400 copies of *Bulletin* **2**(1) | £166 14 4 | |
| Postage and Editor's expenses | 3 5 0 | |
| | | £169 19 4 |
| Postages and Stationery | | 22 15 4 |
| Expenses of January Meeting | | 3 6 6 |
| Subscription to Biological Council | | 0 10 0 |
| Subscription to " Council for Nature " | | 1 0 0 |
| Contribution to Biological Flora articles in J.M.B.A. | | 30 0 0 |
| Bank Charges and Cheque Book | | 1 15 0 |
| | | £229 6 2 |

| *Income* | | |
|---|---|---|
| Subscriptions received, 1960 | £135 0 7 | |
| *Less*: Subscriptions received in arrears, 1958 | 1 0 0 | |
| *Less*: Subscriptions received in arrears, 1959 | 7 0 0 | |
| *Less*: Subscriptions received in advance, 1961 | 16 0 0 | |
| *Add*: Subscriptions in arrears, 1960 | 8 0 0 | |
| | | £119 0 7 |
| Sale of Bulletins | | 46 17 2 |
| Sale of Reprints | 65 0 2 | |
| *Less*: Payments received in arrears, 1959 | 60 11 3 | |
| | | 4 8 11 |
| Sale of Record Cards | | 1 16 0 |
| Interest on Deposit Account | | 4 13 0 |
| *Deficit* | | 52 10 6 |
| | | £229 6 2 |

## BALANCE SHEET AT NOVEMBER 2ND, 1960

| *Capital and Liabilities* | | |
|---|---|---|
| Capital at November 5, 1959 | £263 1 3 | |
| *Less*: 2 Subscriptions written off (1958 and 1959) | 2 0 0 | |
| | | £261 1 3 |
| Subscriptions in advance for 1961 | | 16 0 0 |
| Subtract deficit | | 52 10 6 |
| | | £224 10 9 |

| *Assets* | |
|---|---|
| Balance at Bank | £14 13 0 |
| On Deposit | 201 17 9 |
| Subscriptions in arrears for 1960 | 8 0 0 |
| | £224 10 9 |

(Signed) M. T. MARTIN, *Hon. Treasurer*

We certify that the above Balance Sheet and Income and Expenditure Account are in accordance with the books and vouchers of the British Phycological Society, which we have duly audited, and in our opinion they give a true and correct view of the transactions of the Society for the period from November 6th, 1959, to November 2nd, 1960, and its position at November 2nd, 1960.

(Signed) D. J. CRISP }
J. K. SPEARING } *Hon. Auditors*